Tucson Fire Department
2008
Standards of Response Coverage

Executive Summary

A Standards of Response Coverage (SORC) is defined as those written policies and procedures that establish the distribution and concentration of fixed and mobile resources of a fire service organization. This is accomplished in relation to the potential demand placed on the resources by the type of risk and historical need in the community. The process required to create this document includes reviewing community expectations, setting response goals and objectives, and establishing a system to measure performance. The ultimate goal of the SORC is to structure a response system that saves lives and protects property to the maximum degree possible with the allocated resources.

The primary reason the Tucson Fire Department (TFD) exists is to save lives and minimize property and environmental damage. If there are inadequate resources available and the response is not timely, the emergency will escalate, so fire department resources must be geographically distributed and concentrated in a manner that is both effective and efficient. This is the foundation of a successful SORC.

The risk of fire, medical emergency, or other emergency events cannot be reduced to zero. Thus, the objective of this standard of response coverage study is to identify a balance of distribution, concentration, and reliability that will keep negative outcomes of a particular emergency at a reasonable level while maximizing the saving of life, property, and protection of the environment.

The adoption of a SORC document is new for the TFD. The department has historically operated under a myriad of documents, including a financial sustainability plan, biennial budget, operational memos and directives, policies and procedures, as well as city and state protocols and statutes. These documents are updated on a scheduled and unscheduled basis, depending on the need.

The purpose of this SORC is to evaluate the TFD's current practices through analysis of its goals and objectives and historical response data. The data analyzed in the document is limited to fiscal years 2006-2008. This research will be used to determine the level of service that the department can be expected to deliver. The SORC, in conjunction with the TFD Strategic Plan, will be reviewed annually, or as needed, for applicable updates as the needs and service levels of the community change. Any changes that affects funding, staffing, or resources in an adverse manner are likely to have a negative effect on deployment standards, and will require an immediate analysis to make appropriate adjustments to the SORC document.

Numerous recommendations were generated as a result of the writing of the SORC. Selected recommendations include:

1. Review and revise the department's Strategic Plan and Standards of Coverage documents on at least an annual basis, providing an increased emphasis on emergency service delivery when reviewing the Strategic Plan.

2. Continue to explore the feasibility of mutual/automatic aid agreements with surrounding fire districts to assist with response coverage on the city's borders.

3. Implement a residential sprinkler ordinance for all new construction.

4. Initiate a feasibility study for the 'posting' of less busy units in areas that engender higher call volumes during daylight hours.

5. Improve the quality and compatibility of the Fire Prevention and the City Developmental business databases.

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SECTION 1
Introduction

Tucson is the second largest city in Arizona. Located 60 miles north of the Mexican border, it is the largest metropolitan area in southern Arizona, encompassing an area of 195 square miles. The 2000 census identified 525,936 residents within the Tucson city limits and another 420,000 in the immediately surrounding area.

The City of Tucson provides 911 and central dispatching services to the Tucson Fire Department and six other surrounding fire districts.

Included within the Tucson Fire Department's response area are:

- Davis Monthan Air Force Base
- The Army National Guard Transportation Park
- The Air National Guard Base
- The US Air Force's principal storage facility for inactivated aircraft
- Tucson International Airport
- The University of Arizona main campus
- University of Arizona Science Park
- Union Pacific Railroad Yard
- Raytheon Company
- A major petroleum storage and distribution yard
- A major water distribution site
- Eight hospitals
- Several major shopping malls

In addition to its primary response area, the Tucson Fire Department is a signatory to several state and regional response plan agreements. The Statewide Mutual Aid agreement provides assistance statewide during major incidents. The Metropolitan Medical Response System provides medical assistance statewide during a major medical emergency. The Regional Hazardous Materials Response agreement provides hazardous materials response assistance to several local fire district and agencies within southern Arizona.

In 2006, the Tucson was designated an Urban Area Security Initiative (UASI) city due to the critical infrastructure that it protects along with the risk factors identified in the area.

Demographics

The 2000 census identified 525,936 residents within the Tucson city limits and another 420,000 in the immediately surrounding area. More recent estimates from the Department of Economic Security indicate the population to be 544,445 within the city's boundaries with another 460,000 in the surrounding areas. Seasonal residents, many of whom are senior citizens, cause the population to grow by several thousand during the winter months.

The United States Fire Association has identified three populations that are most at risk from fire. They include children under the age of 5, physically disabled people, and people over the age of 65. Population projections from the Arizona Department of Economic Security estimate that children under 5 make up approximately 6.5% of the population of Pima County and adults over the age of 65 make up approximately 13.1% of the population.

Growth Issues

Tucson was the 45th largest city in 1980 in the United States, 34th largest in 1990 and 30th largest in 2000. The population growth rate for the next 25 years should average about 1.8% per year. The central core area encompasses approximately 27 square miles and had a 2000 population of 138,807 people. That population figure represents an increase over 1990 of 5,566 people, a growth rate of 4.2%. The mid-city growth area contains 51% of the city's population. From 1990-2000, the area gained 30,154 people for an estimated population of 251,765. This represents a 13.6% increase in population for this area. The areas at the outer boundaries of the city are experiencing significant development activity but over 40 percent of the land is still undeveloped. Much of this land has the potential for commercial and/or residential development. Census data shows that in 1990 this area contained only 15% of the city's population, however, it has experienced a 44.4% population increase to an estimated population of 90,230 persons in the year 2000. The population in this area is more affluent than the city as a whole, with poverty rates and unemployment rates at a relatively lower 10% and 5%, respectively. This area is projected to receive a significant portion of the new development and population growth of the city by 2010.

Weather and Topography

The City of Tucson lies within the Sonoran Desert in Southeastern Arizona. Elevations above sea level within the city boundaries vary from approximately 2,200 feet in the Santa Cruz River floodplain to approximately 3,100 feet on the peak of Tumamoc Hill west of the downtown area. Average rainfall is approximately 11 inches, the vast majority of which falls during July/August and the winter months. The typical relative humidity is low compared to many other areas of the country, with humidity readings in the single digits not uncommon in late spring and early summer months. The major weather event in the city usually consists of severe thunderstorms that are triggered by a monsoonal moisture pattern from the Gulf of Mexico, generally occurring in July and August. These storms often produce heavy lightning and spark flash flooding and strong microburst winds, which can exceed 70 mph. Winters are generally mild, with an average of only fifteen nights dropping below freezing. Daytime highs during winter months are generally 60-75 degrees and daytime highs during the summer months range from 95-115 degrees. The area is susceptible to prolonged drought periods. Southern Arizona is currently in the midst of a multi-year drought.

The majority of the city lies on gentle to moderate foothills with typical Sonoran Desert vegetation that is light to moderate in density. Three river systems, the Santa Cruz, Rillito, and Pantano, run through the incorporated area. All of the rivers and washes are seasonal, with the exception of several miles of the Santa Cruz River northwest of the city which has a perennial flow of water from two wastewater treatment plants.

Water Supply

As in any desert community, water is a critical resource. There are two basic sources of water in the city with groundwater from beneath the Tucson Basin being the primary source. In addition, the Central Arizona Project canal provides an additional shared source of water from the Colorado River. Currently, this imported water is blended with native groundwater prior to service delivery and in the future will account for the majority of water usage in the city. Effluent is also a growing source of water but, currently, this is limited to irrigation of golf courses, parks, and other grass areas in the city. With the continued development of the use of Central Arizona Project water and effluent, along with an aggressive conservation program, it is projected the area will have sufficient water supply to keep pace with the projected growth. The city is served by Tucson Water which is owned and operated by the City of Tucson. The city's urban/suburban developed areas are provided with an adequate water distribution network, including over 11,058 hydrants.

Tucson Fire Department

The Tucson Fire Department (TFD) is an all-hazards trained department, responding to fire, medical, hazardous materials, and technical rescue emergencies. All emergency and non-emergency services are developed, maintained, and provided by 745 members, including 673 commissioned personnel and 72 non-commissioned personnel.

TFD responds to emergencies from 21 fire stations, comprised of 22 engine companies, ten ladder companies, 18 paramedic companies, and two alternative service delivery companies. TFD also maintains specialty response teams for hazardous materials and technical rescue. A listing of apparatus and equipment assignments can be found in Appendix A. To carry out its mission, TFD is organized into six divisions: Administration, Operations, Emergency Preparedness, Fire Prevention, Support Services, and Training and Safety. (Figure 1.1)

- Administration provides direction and policy to the entire department, and includes human resources and financial components.
- The Operations Division protects lives and property by responding to fire and medical emergencies, performing pre-fire planning inspections, and

presenting public education programs to increase fire and life safety awareness.

- The Emergency Preparedness Division handles the administrative side of emergency medical service delivery and emergency management/homeland security.
- The Support Services Division supports the department by procuring and distributing supplies and equipment, and keeping all vehicles and equipment in a fully functional condition. The Community Safety/Public Information and Information Technology Sections provide public education and technological support to the department, respectively.
- The Training and Safety Division provides training for new and existing fire department personnel to ensure well-trained public servants. The division has developed a regional training program to provide standardized and specialized training to regional fire districts and agencies. The Safety and Wellness Section works to prevent or reduce the severity of injuries and exposures to contagious diseases, while enhancing the overall health and wellness of all department members.
- The Fire Prevention Division promotes public safety by administering fire codes and standards, conducting commercial building inspections, enforcing compliance of code requirements and investigating suspicious fires.

The TFD uses a three-shift platoon system to provide 24-hour staffing of a minimum of 178 firefighters on duty. A battalion chief manages each of four districts and a captain manages each company and station. Currently, nine deputy chiefs occupy administrative positions. Additionally, each division is managed by an assistant chief or administrative manager.

Tucson Fire Department Mission Statement and Goals

The Tucson Fire Department mission statement, goals and objectives serve as the guidelines for establishing the Standards of Response Coverage. By evaluating past performance and trends, through risk assessment, critical tasking and the setting of realistic and justifiable standards of coverage statements, we hope to improve future deployment decisions and maximize the service provided to the citizens of Tucson. These goals and objectives are reviewed and updated annually via the budget process.

Tucson Fire Department Mission Statement

To protect the lives and property of the citizens of Tucson from natural and manmade hazards and acute medical emergencies through prevention, education and active intervention.

Tucson Fire Department Goals

1. Prevent and reduce the loss of life and property within the Tucson community through fair and consistent administration of the fire code.

2. Reduce the loss of life and property within our community through pro-active public education programs.

3. Provide rapid, effective emergency response to our community through appropriate deployment and support of staffing, apparatus and equipment.

4. Prepare for catastrophic events and minimize risk to our community.

5. Improve our internal and external customer service through continuous assessment, progressive management and quality personnel practices.

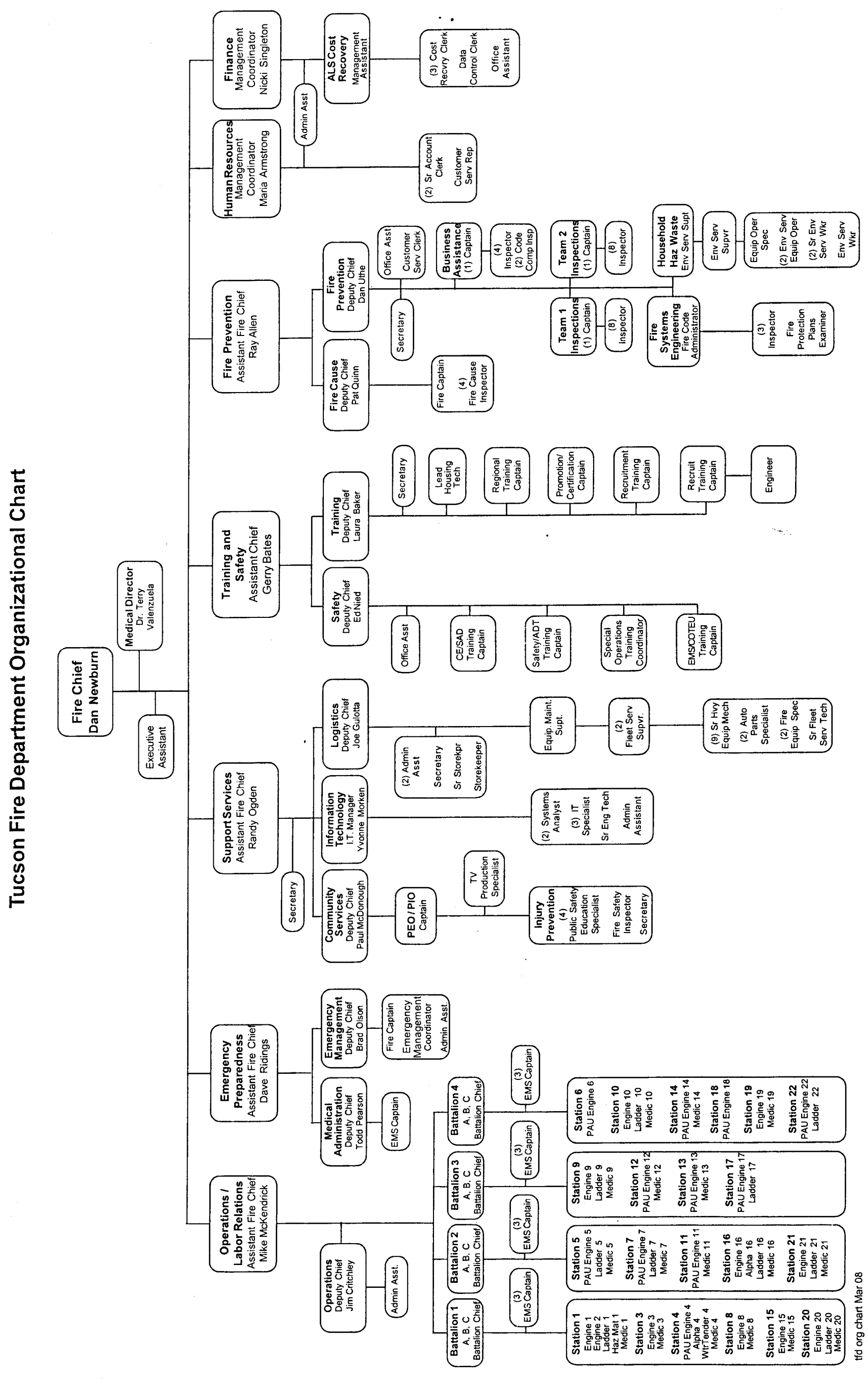

Figure 1.1. Tucson Fire Department Organizational Chart, June, 2008.

SECTION TWO
Risk Assessment

Risk assessment consists of six key elements:

Community profile - The overall profile of the community based on the unique mixture of demographics, socio-economic factors, occupancy risk, demand zones and the level of services currently provided.

Consequence - There are two components: life safety (the number of people endangered by a life-threatening situation) and economic impact (the losses of property, income or irreplaceable assets).

Demand zones - An area used to define or limit the management of a risk situation. This document identifies three demand zones which are further divided into quarter-mile squares.

Fire Flow - The amount of water required to control the emergency. This is based on contents and combustibles materials.

Occupancy risk - The relative risk to life and property resulting from a fire or other hazard inherent in a specific occupancy or in generic occupancy class.

Probability - The likelihood that a particular event will occur within a given period of time. An event that occurs daily is highly probable. An event that occurs only once in a century is very unlikely.

The risk assessment is utilized to determine what people and property are at risk in the community in order for the fire department to develop deployment strategies for its resources. The goal of this risk assessment is to determine the probability of an event occurring and the consequence of that event. To properly determine probability versus consequence of an event, TFD identified risk factors and created three risk categories – high, medium and low risk. Occupancies in the city were evaluated for their risk factors and placed into a risk category.

Risk Factors

In order to categorize risk within the City of Tucson, risk factors must first be identified. A risk factor may be defined as any factor that:

- Increases the need for the fire department to arrive quickly and/or
- Increases the number of firefighters needed to control the situation.

The City of Tucson is currently working under the 2006 International Fire Code. The City of Tucson adopted its first building code in 1928 and its first fire code in 1973.

Since then, all buildings have been constructed under both the most current companion Building Codes and Fire Codes. As a result, nearly all commercial buildings newly built or retrofitted since that time have some level of fire protection system as required by the code at the time of construction. In addition, the city's design standards are written to ensure the fire department's ability to respond with all forms of apparatus. In essence, over the years, the city's built environment has conformed itself with the fire department's ability to respond.

Specific factors included in these requirements are:

- Size of the building
- The ability of occupants to take self-preserving actions
- Nature of the occupancy and its contents
- Built in fire protection
- Historical significance

Group A (Assembly)
Division 1 & 2 (very large assembly occupancies) – all (1979)
Drinking – 5000 sq.ft. (1982)
Drinking – more than 100 occupants (2006)
Exhibition – 12,000 sq.ft. (1979)
Multitheater – all (1991)
Amusement - all (1991)

Group B (Business - now Group M)
12,000 sq.ft. (1982)

Group E (Educational)
All 2 story or more (1979)
All – (1994)

Group H (Hazardous)
Division 1, 2, 3, 6, and 7 – all (1985)
Division 4 – 3,000 (1985)

Group I (Institutional)
All (1979)

Group R (Residential)
Division 1 – three stories (1979)
All but R-3 (homes) (2000)
All including R-3 (2006)
Basements – 1500 sq.ft. (1979)

Table 2.1. Occupancy classifications and date of sprinkler requirements.

Risk Categories

Four levels of risk were identified with the level of risk based on the type of occupancy and/or the type of incident.

High Risk

The Tucson Fire Department defines high risk occupancies as those that are:

- Three or more stories (sprinklered or unsprinklered).
- Two stories with a basement (sprinklered or unsprinklered).
- Hospitals.
- Full-time care centers, sprinklered or unsprinklered, that are occupied with 20 or more people with a limited ability to take self-preserving actions in an emergency (i.e., nursing homes).
- Unsprinklered buildings with over 12,000 square feet of open space with no occupancy separations (i.e., churches, warehouses).
- Buildings of great historical significance that may not fit in the above categories.

By design, these occupancies require a higher level of initial response to address life hazards and fire suppression. Most of these structures are located in the central core area of the city.

Moderate/Typical Risk

The vast majority of structures in the city fit into this category. The determination of moderate risk is based on a lesser potential for high fire or life loss than those in the high risk category. The risk of life loss or damage to property resulting from a fire in a single occupancy is usually limited to the occupants, although in certain occupancies, such as a small apartment complex, the risk of death or injury may be relatively high. Most occupancies in the moderate risk category are less than 12,000 square feet, but larger one or two story occupancies are considered in this category because the required built-in fire protection and/or compartmentalization should limit the potential fire and life loss. These occupancies can be found throughout the central core and mid-city areas of the city.

Low Risks

Occupancies are classified as low risk due to their negligible life-safety risk, minimal property value and/or limited proximity to other structures.

Special Risks

Certain incident types are seen and treated as special risks and are given appropriate predetermined responses. Examples of such incident types are:

- Aircraft accidents.
- Railroad accidents.
- Chemical spills/releases.
- Major medical incidents, regardless of location.
- Technical rescues (confined space, high angle, swift water).

Demand Zones

The City of Tucson Development Plan (2001) identified three basic land use zones: Urban/Industrial, Suburban, and Remote/Isolated.

The Urban/Industrial designation identifies areas that include or are planned for high-density residential and major commercial and industrial employment generators. These include research, commercial, and industrial parks and campuses and other industrial uses. High-density residential uses, such as apartments, condominiums, and town homes are generally developed along major transportation corridors and close to activity centers such as the University of Arizona, the Downtown area, and other commercial and employment generators. This land use pattern may also include a range of office, commercial, churches, public and private schools, parks and recreation areas, and public and semipublic land uses. This area is also known as the central core.

The Suburban designation identifies areas that are primarily made up of and planned for housing units at densities up to approximately six housing units per acre. This includes the range of densities allowed in low-density zoning categories, though zoning classifications with higher densities may be found along major streets. Planned residential/mixed use developments with natural and consolidated open space may also be located in these areas. The designation also encompasses the majority of single-family housing units currently located in the mid-city and planned housing communities on the outer boundaries of the city. While the basic character of development is suburban with single-family dwellings, a mixture of duplexes, town houses, and apartment complexes may also occur within this designation. These occupancies typically occur along major streets or as components of neighborhoods. This designation also includes such supporting land uses as neighborhood office and commercial uses, churches, park and recreation areas, and public and private schools.

The Rural/Isolated designation identifies areas that are typically found in existing edge areas, usually in lower density residential zoning categories. Planned residential developments with natural or consolidated open space may be located in these areas, as well as limited office and commercial services at the intersections of major streets and public and private facilities.

The city's land use designations were integrated with the department's quarter-square mile plate mapping system to determine TFD response demand zones. This system encompasses 920 plates. (Figure 2.1) Except for a few notable exceptions, the great majority (99.1%) of high risk occupancies were found in the Urban/Industrial and Suburban zones.

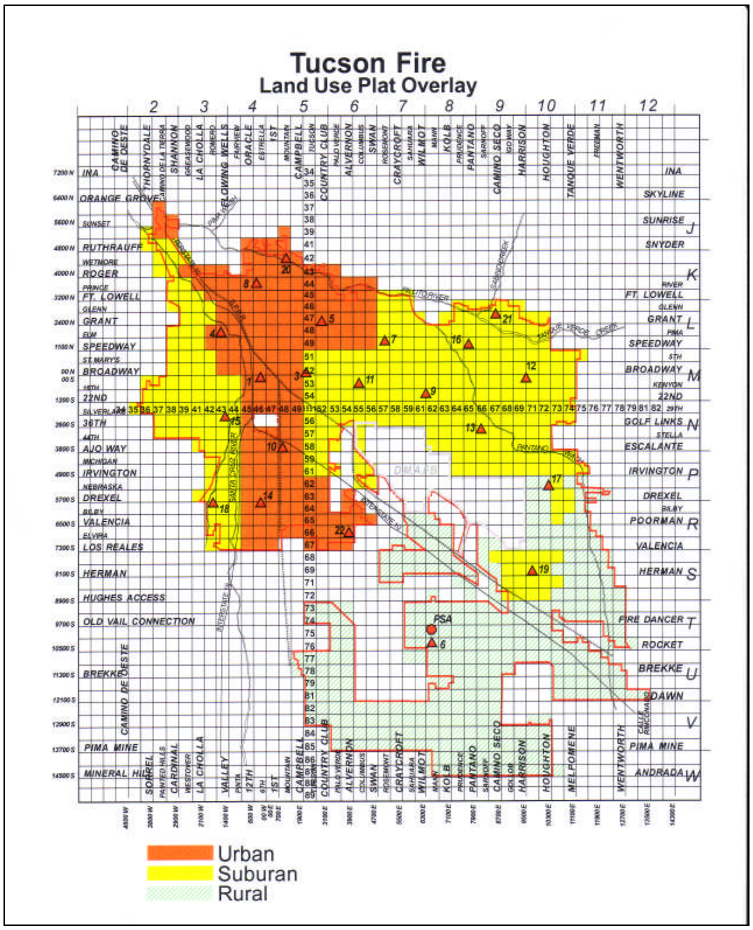

Figure 2.1. Demand Zones by Plate Map.

Probability

In order to assess the probability of an event occurring, a study of call types and call frequency was conducted. The study was conducted for all calls for service over the last three years. Those results are exhibited below.

The Tucson Fire Department responded to 79,940 incidents in Fiscal Year 2008. Six groups of calls were examined; Fires, Emergency Medical ALS (EMSALS), Emergency Medical BLS (EMSBLS), Alpha Truck Calls, Hazardous Materials (HazMat) and Technical Rescue (Trench/High Angle/Confined Space/Swift Water Rescue). All groups were looked at in order to determine frequency over the last three years, resulting in the probability of the event occurring in the future.

The City of Tucson has experienced rapid growth over the last fifteen years, resulting in a steady increase in call volume during that time. The City of Tucson Development Plan estimates the City's population to reach 588,558 by 2010 and 651,000 by 2015. This growth, as well as factors such as age of the community and structures, redevelopment projects, and in-fill strategies will become the driving factors for projecting call volume.

Currently, TFD responds to a call for service every 3.3 minutes. This is an average of 218 calls for service per day. (Table 2.2) This represents an increase in annual call volume of 3.8% from FY2006 to FY2007 and 4.4% from FY2007 to FY2008. The average duration of each medical call is approximately 39 minutes from the time of dispatch to the time the unit returns to service, while the average non-medical call runs approximately 21 minutes.

All Calls	FY2006	FY2007	FY2008
Total Incidents	73,750	76,559	79,940
Daily Average	202.05	209.73	218.42
Unit Responses	127,462	130,805	137,917
Daily Average	349.21	358.37	376.82

Table 2.2. All fire department incidents and unit responses from FY2006 through FY2008.

Tables 2.3, 2.4, 2.5 and 2.6 looks at daily call volume per call type throughout the city and within each of three demand zones. The Urban/Industrial Demand Zone comprises 23% of the city, contains 54.4% of the high risk occupancies and 51.2% of the commercial occupancies, and generates 47.7% of the department's call volume. The Suburban Demand Zone comprises 41% of the city, contains 22.8% of the high risk occupancies and 44.2% of the commercial occupancies, and generates 49.2% of the department's call volume. The Rural/Isolated Demand Zone comprises 36% of the city and contains a total of four high risk occupancies and 4.6% of the commercial occupancies. This zone generates 3% of the call volume. Although the Suburban Demand Zone generates a slightly larger proportion of the total call volume than the Urban/Industrial Demand Zone, it is spread over nearly twice the area. This factor, plus the fact that it contains fewer than half of the high risk occupancies, indicates the need for a greater concentration of stations/units within the Urban/Industrial Demand Zone.

Call Type	Call Volume	Daily Average
Fires	25,000	22.8
EMS ALS	58,200	53.1
EMS BLS	136,728	124.9
* Alpha Truck Calls	10,108	9.23*
HazMat	2,247	2.1
Technical Rescue	210	.2
Total Incidents	230,242	210.3

Table 2.3. Summary of selected incidents for the entire City of Tucson, FY2006 through FY2008. *Alpha 4 was placed in service April, 2006 and Alpha 16 was placed in service in October, 2007. Alpha 9 and Alpha 10 were staffed when possible. Most Alpha Calls are EMS BLS with some fire suppression responses.

Call Type	Call Volume	Daily Average
Fires	12,180	11.11
Structure Fires	520	.47
EMS ALS	24,476	22.33
EMS BLS	67,254	61.36
* Alpha Truck Calls	6,485	5.92
HazMat	1,093	1
Technical Rescue	54	.05

Table 2.4. Summary of selected incidents within the Urban/Industrial Response Zone - FY2006 through FY2008.

Call Type	Call Volume	Daily Average
Fires	11,600	10.58
Structure Fires	487	.44
EMS ALS	31,380	29.04
EMS BLS	62,510	57.03
* Alpha Truck Calls	3,601	3.29
HazMat	1,071	.98
Technical Rescue	40	.04

Table 2.5. Summary of selected incidents within the Suburban Response Zone - FY2006 through FY2008.

Call Type	Call Volume	Daily Average
Fires	1,018	.93
Structure Fires	29	.03
EMS ALS	1,742	1.59
EMS BLS	3,879	3.54
* Alpha Truck Calls	62	.06
HazMat	79	.07
Technical Rescue	12	.01

Table 2.6. Summary of selected incidents within the Rural/Isolated Response Zone - FY2006 through FY2008.

Fires are a daily event in Tucson. The majority of Tucson fires are brush, rubbish and automobile fires. Over 65% of fire related calls result in finding no fire on arrival (i.e., fire alarms, fire out on arrival, smoke in area). A total of 25,000 fire responses were generated during Fiscal Years 2006 to 2008. Of these, 1,009 (4%) were structure fires.

Type of Fire	FY2006	FY2007	FY2008
Structure Fires	372	316	321
Contained to Room of Origin	75.27%	74.05%	72.8%
Vehicle	498	513	432
Brush	1,143	940	1,056
Refuse	869	720	724
Other Fires	201	221	201
Total Fire Calls	3,083	2,710	2,734
Other Fire Related Calls	5,693	5,362	5,418
Total Fire Related Calls	8,776	8,072	8,152
Daily Average	24.04	22.12	22.34
Arson Fires	1,585	1,377	1,363

Table 2.7. Break down of fire incidents from FY2006 through FY2008.

As is the case of other fire departments across the nation, the largest percentage of emergency calls in Tucson are for Emergency Medical Services (EMS). The steady growth that Tucson is experiencing has resulted in a similar increase in EMS calls over the last four years. In FY2008, TFD responded to 183.34 EMS calls a day, thus, an EMS call occurs every 3.93 minutes.

EMS ALS	FY2006	FY2007	FY2008
Total Calls	19,436	19,043	19,721
Daily Average	53.25	52.17	54

Table 2.8. ALS emergency medical responses from FY2006 through FY2008.

EMS BLS	FY2006	FY2007	FY2008
Total Calls	44,691	44,839	47,198
Daily Average	122.44	122.85	129.31

Table 2.9. BLS emergency medical responses from FY2006 through FY2008.

Alpha Trucks are staffed by EMTs and provide care for minor injuries or illnesses via a pick-up truck rather than more expensive ambulances or larger fire vehicles. The purpose of this program is not only to take some of the response burden from the engine and ladder companies, but to reduce the number of calls going through the 911 system by providing social service referrals and assistance, as needed.

Alpha Truck	FY2006	FY2007	FY2008
Total Calls	663	2,794	6,702
Daily Average	NA*	7.65	18.36

Table 2.10. Alpha Truck responses from FY2006 through FY2008. The Alpha program was introduced in April, 2006.

Hazardous material related events are small and relatively infrequent in the City of Tucson. This can be attributed in a large degree to the Fire Prevention Bureau Hazardous Material Management Plan inspection program and Household Hazardous Waste collection. For the three year period, the TFD responded to an average of 749 HazMat calls per year, resulting in two hazardous materials calls every day. The most frequent events are construction related gas line breaks (30%) and small, vehicle-related gasoline spills (59%).

HM	FY2006	FY2007	FY2008
Total Calls	793	710	744
Daily Average	2.17	1.95	2.04

Table 2.11. Hazardous materials incidents from FY2006 through FY2008.

Technical Rescue events are also relatively infrequent. The majority of them are swift water rescues with the great majority of these occurring during the summer ‘monsoon’ season.

TRT	FY2006	FY2007	FY2008
Swift Water	6	10	22
Other TRT	48	5	14
Total Daily Aver.	.15	.04	.1

Table 2.12. Technical rescue incidents from FY2006 through FY2008.

Buildings

Tucson is a rapidly growing community. For planning purposes the City of Tucson Planning Department utilizes estimates derived from current census and building permits to track the number and type of residential and non-residential buildings in the city limits. (Tables 2.13 and 2.14)

Residential Type	Number of Units
Single Family	119,609
2-9 units	25,112
> 10 units	47,831
Mobile Homes	16,325
Total	208,877

Table 2.13. Types of residential buildings (Source: Tucson Urban Planning and Design and 2000 census).

Commercial buildings include industrial, retail and office occupancies. Industrial occupancies are light manufacturing, warehouses, and wholesaling activities. Retail occupancies include retail, grocery, gas stations, restaurants, hotels and car lots and malls. This includes 216 shopping centers with 25,000 feet or more. Offices include administrative and professional offices, medical plaza, civic centers, etc.

Commercial Type	**Number of Occupancies**
Industrial	3,957
Retail	14,746
Office	6,824
Total	25,527

Table 2.14. Types of commercial buildings (Source: Tucson Department of Development Services, 2007).

Temporal Analysis

Table 2.15 and Figure 2.2 display the average number of incidents per day per month for FY2006 through FY2008, with February proving to be the busiest month and October the slowest. Two factors contribute to this phenomenon. Tucson hosts a large number of winter visitors, many of them elderly and requiring a greater demand for emergency medical service. February is also generally regarded to be the height of the 'flu season' in the Tucson area.

		Average Per Day	Totals
Month	January	207.67	19,313
	February	219.74	18,678
	March	217.61	20,238
	April	214.12	19,271
	May	213.10	19,818
	June	212.63	19,137
	July	210.29	19,557
	August	209.39	19,473
	September	204.33	18,390
	October	201.96	18,782
	November	202.94	18,265
	December	208.09	19,352
Total			**230,274**

Table 2.15. Average number of incidents per day per month.

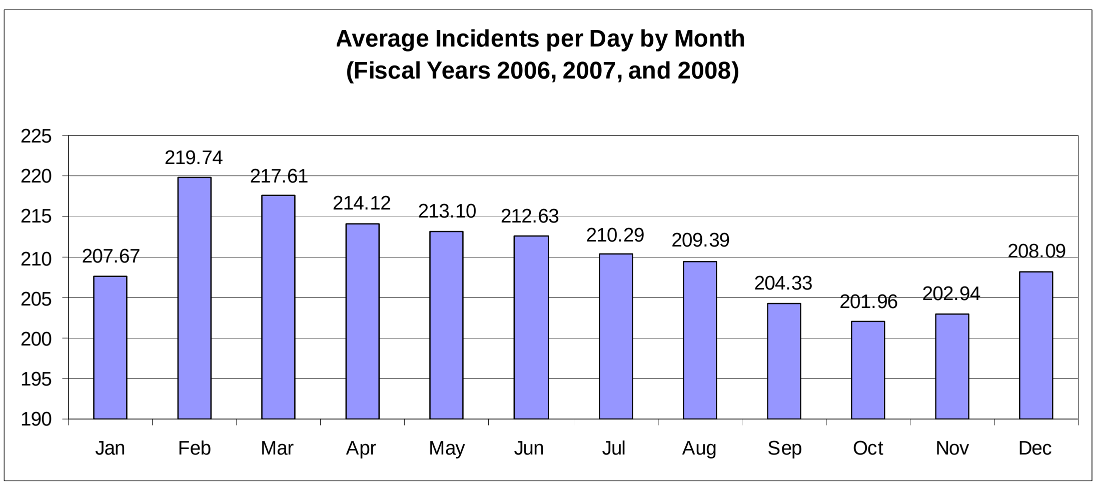

Figure 2.2. Distribution of call volume per day per month, FY2006-FY2008.

Table 2.16, Figure 2.3 and Figure 2.4 show the daily temporal distribution of all responses, all fire responses and all ALS and BLS responses for FY2006 through FY2008. Call volume is highest between the hours of 0900 and 2200, peaking between the hours of 1500 and 1800. ALS calls peak between the hours of 1000 and 1400, while BLS calls peak later in the day (1500 to 1900) and fire calls a little later (1700 to 2000). Interestingly, structure fire activity is highest in the early afternoon (1200 to 1500), drops slightly, and then picks back up during the hours of 1700 to 1900. The ratio of ALS calls to total calls is highest from 1000 to 1200 (28%) and lowest (23%) around midnight. For BLS calls, the highest ratio to total calls comes between 1500 and 1800 hours (59%), and is lowest (55%) between 0900 and 1100.

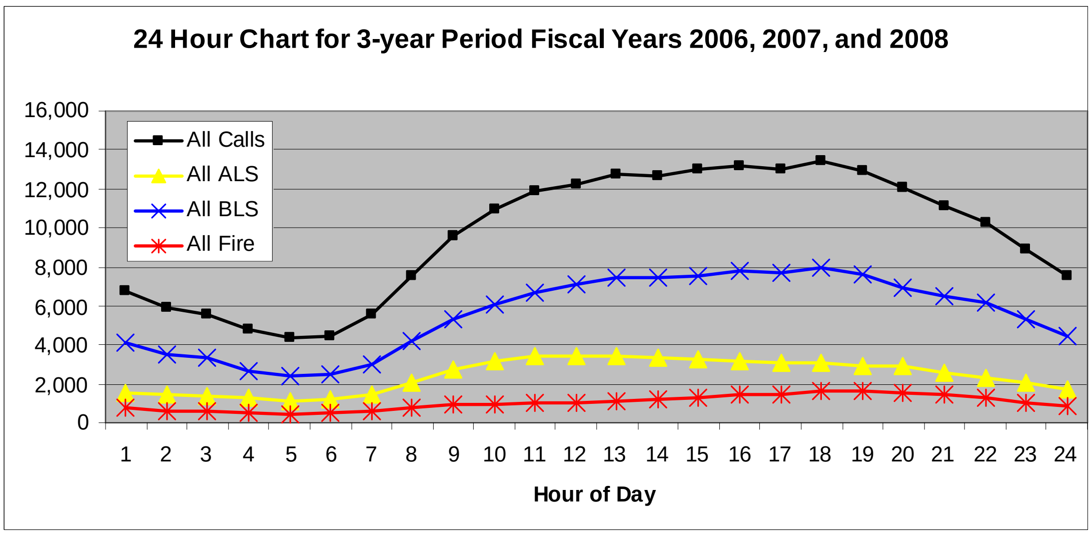

Figure 2.3. Distribution of incidents by the hour of the day – All Incidents FY2006-FY2008.

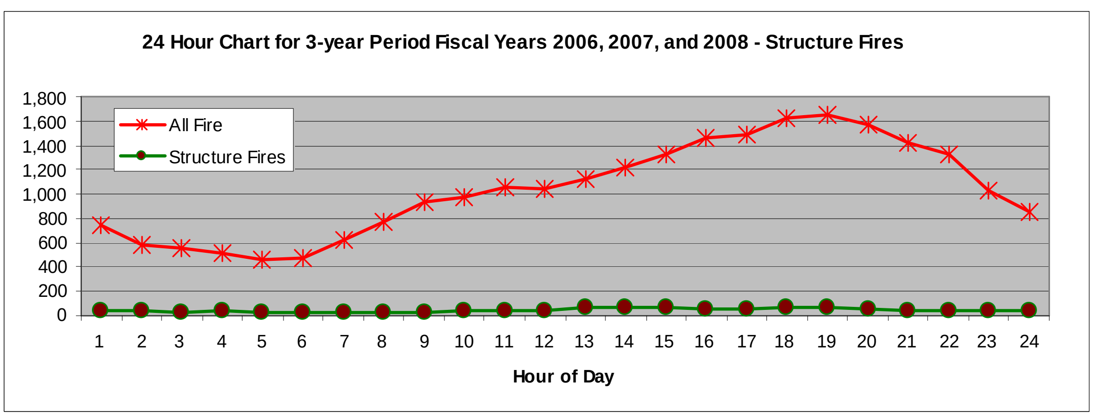

Figure 2.4. Distribution of structure fire incidents by the hour of the day –FY2006-FY2008.

		All Calls	ALS	BLS	All Fire	Structure Fire
Time of Day	**0000 – 0059**	6,797	1,542	4,144	742	38
	0100 – 0159	5,910	1,477	3,494	580	36
	0200 – 0259	5,570	1,382	3,320	557	24
	0300 – 0359	4,754	1,249	2,692	508	37
	0400 – 0459	4,336	1,150	2,420	456	27
	0500 – 0559	4,443	1,220	2,463	478	28
	0600 – 0659	5,548	1,488	3,019	618	26
	0700 – 0759	7,498	2,042	4,184	770	25
	0800 – 0859	9,605	2,741	5,295	929	31
	0900 – 0959	10,936	3,185	6,076	981	38
	1000 – 1059	11,879	3,431	6,651	1,056	37
	1100 – 1159	12,221	3,400	7,069	1,037	46
	1200 – 1259	12,763	3,394	7,469	1,118	68
	1300 – 1359	12,684	3,324	7,422	1,220	63
	1400 – 1459	12,983	3,233	7,572	1,324	61
	1500 – 1559	13,137	3,168	7,752	1,458	56
	1600 – 1659	12,990	3,060	7,677	1,490	53
	1700 – 1759	13,421	3,076	7,955	1,629	61
	1800 – 1859	12,893	2,893	7,646	1,651	62
	1900 – 1959	12,083	2,906	6,961	1,571	54
	2000 – 2059	11,118	2,604	6,475	1,420	45
	2100 – 2159	10,287	2,287	6,130	1,325	45
	2200 – 2259	8,874	2,057	5,288	1,031	37
	2300 – 2359	7,544	1,740	4,469	847	38
Total		**230,274**	**58,049**	**133,643**	**24,796**	**1,036**

Table 2.16. Distribution of incidents by the hour of the day – All Incidents FY2006-FY2008.

Large Scale Risks

While not having many of the significant natural disaster risks that other areas of the country have, the Tucson Fire Department recognizes that there are, nonetheless, large scale hazards within its boundaries that have the potential to significantly impact the Tucson community in several ways including:

- Life safety
- Economic
- Environmental
- Social

TFD's Disaster Management Section is charged with the identification of major large scale hazards and rating them in terms of community vulnerability and hazard potential. The process utilized to rate the hazards involved:

1. Listing large scale hazards that are known to exist within the City of Tucson and Pima County based on history, staff experience, and a review of the department's geographic, economic, environmental, and infrastructure profile.
2. Determine the probability of occurrence.
3. Determine the vulnerability for each hazard.
4. Classify the hazards into three levels; high, moderate, and low.

Seven large scale hazards were identified and rated.

Hazardous Material (HAZMAT) Event (High)

This includes fixed site and transportation incidents. The transcontinental railroad, Interstate 10, and high pressure/high capacity natural gas and petroleum product pipelines transect the Tucson community. The threat of any hazardous material event may be magnified due to restricted access, reduced fire suppression and spill containment, and even complete isolation of response personnel and equipment. Natural hazards, such as high winds and/or rain, may complicate response activities. In addition, the risk of terrorism involving hazardous materials is considered a major threat due to the location of hazardous material facilities and transport routes throughout communities and the frequently limited anti-terrorism security at these facilities. Four significant HAZMAT events have occurred within the Tucson city limits since 1990 and 2003. The TFD Hazardous Materials Response Team, along with the Public Safety Emergency Management and Homeland Security Section (PSEMHSS), has identified major "target" hazards and completed pre-planning activities for them. Should there be a large release of a hazardous material in gas form within the city limits, thousands of residents could potentially be adversely affected.

Thunderstorm (Moderate)

Thunderstorms occur throughout the year in Tucson, but most commonly during the monsoon season as the seasonal wind shift brings a dramatic increase in moisture to the region. Severe thunderstorms produce heavy rain, flash flooding, severe winds, hail, and lightning, all of which are addressed in detail elsewhere within this document. Rainfall is the most recognizable attendant feature of thunderstorms posing a significant flash flooding hazard, with normal annual precipitation rates varying across the county. Severe thunderstorms may also produce hail. Another hazardous feature of severe thunderstorms is tornadoes, which are generally rare in Pima County, but may cause damage and are most common in the summer months.

Flood (Moderate)

In mid- to late-summer the monsoon winds bring humid subtropical air into Arizona. Solar heating triggers potentially devastating afternoon thunderstorms. Flash flooding often results as heavy rains are dumped in confined areas over a relatively short timeframe. Flash floods involve a rapid rise in water level, high velocity, and large amounts of debris that can lead to significant damage including the tearing out of trees, undermining of buildings and bridges, and scouring of new channels. The degree of flash flooding is a function of the intensity and duration of rainfall, steepness of the watershed, stream gradients, watershed vegetation, natural and artificial flood storage areas, and configuration of the streambed and floodplain.

Extended power failure (Moderate)

Should there be a widespread, extended interruption of power within the city limits, there would be, potentially, serious consequences for the delivery of emergency services. These include a number of service delivery issues, such as the emergency notification process, failure of traffic control devices, and, depending on the time of year, a spike in temperature related exposure incidents. Each fire station has a generator to provide electrical power in the event of a power failure.

Large Aircraft Crash (Moderate)

Tucson is home of the Davis-Monthan Air Force Base (DMAFB), the Arizona Air National Guard (AANG) and Tucson International Airport (TIA). In addition, a municipal airport (Marana/Northwest Regional Airport) and one large private airport are located within twenty miles of the Tucson's northwest border. Tucson has experienced two major aircraft crashes within the City itself in the last 35 years. The department conducts regular training exercises with DMFB, the AANG and TIA to become familiar with various types of aircraft that fly over the city and the hazards they can present in an emergency.

Urban/Wildland Interface Wildfire (Low)

A wildfire is an uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures. Wildfires can be human caused through acts such as arson, campfires, or the improper burning of debris, or can be caused by natural events such as lightning. The severity of urban/wildland interface fires relies on the relationship between three primary fire potential factors: topography, critical fire weather, and fuel availability. The majority of Pima County's topography, including the City of Tucson, involves slopes of less than 40%. Tucson experiences 35 to 60 very high or extremely high critical fire weather days per year during the summer months. Within the city limits of Tucson, the fuel availability is relatively low with the exception of isolated areas on the outer limits of the city and the A Mountain area. Although the urban and suburban characteristics of Tucson make large wildfires unlikely, as the city expands and annexes more undeveloped land, the factors that contribute to wildfires take on greater importance.

Earthquake (Low)
In general, the risk of a seismic hazard affecting Tucson is relatively low, however, denser populations, existence of high rise buildings, existence of unreinforced masonry buildings, and the lack of earthquake awareness among its population elevate the risks associated with seismic activity. The last sizeable earthquake to affect Pima County was in 1887. More significantly, a catastrophic southern California earthquake would have a major economic impact on the metropolitan area as it would potentially disrupt 60% of Arizona's fuel and 90% of Arizona's food goods.

Summary:
While performing the risk assessment, three response zones were identified: Urban/Industrial, Suburban, and Rural/Isolated. In addition, five structure and/or occupancy types were identified as being high risk. Additionally, the response data for the last three years was reviewed to determine the probability of occurrence of six call types: structure fires, ALS emergency medical responses, BLS emergency medical responses, Alpha Truck responses, hazardous materials incidents, and technical rescue incidents.

As is the case in most communities, the daily emergency event in Tucson is of the moderate risk type. Medical responses are far and away the most frequent emergency response. Fire emergencies in high risk occupancies are relatively rare, but the potential life and/or property loss is great. Thus, TFD response companies must be adequately distributed to handle the daily moderate risk occurrence, while providing a concentration of units to support the requirements of the high risk occupancies.

Finally, the risk assessment must be reviewed and updated on a regular basis in order to adequately respond to growth and changing occupancies within the City of Tucson. The risk assessment will continue to be used as part of the Standards of Response Coverage document to evaluate the concentration and distribution of resources in order to provide a response capable of effectively and efficiently handling all risks of all types.

SECTION THREE
Time and On-Scene Performance Expectations

The dynamics associated with fire and medical emergencies directly influence decisions related to fire station location and company staffing patterns. Structuring the arrival of appropriate resources to positively interrupt fire growth or life-threatening medical conditions is one of the greatest challenges to fire service managers. Time and on-scene performance expectations are those target indicators established for effective and efficient response to emergency incidents. This section outlines TFD's response time goals, as well as how and why those response times are determined.

Cascade of Events
The Commission on Fire Accreditation International has defined response time elements as a cascade of events that lead up to the initiation, mitigation and ultimate outcome of cardiac arrest.

It is assumed in the development of this concept that if a state of normalcy exists there is no reason for an emergency services organization to respond. A state of normalcy describes a condition under which there is no indication to a person in a given situation that there is an immediate threat to life or property. The remaining time points and intervals are on a continuum.

Time Points and Time Intervals (The Continuum)
Event Initiation - The point in time when events occur that may ultimately result in an activation of the emergency response system. Precipitating factors can occur seconds, minutes, hours, or even days before there is a perception that an event is occurring. For example, a person may ignore chest discomfort for days prior to making a decision to seek assistance. Rarely is it possible to quantify the point at which event initiation occurs.

Emergency Event - The point in time when conditions exist that cause an activation of the emergency response system. Considered the 'Point of Awareness', it may be the recognition by an individual that assistance is needed, or it may consist of a mechanical or electronic recognition of an event such as smoke or heat detector activation.

Alarm - The point in time when the emergency response system is activated. The transmittal of a local or central alarm to public safety answering point is an example of this time point. Again it is difficult to determine with any degree of reliability the time interval during which this process occurs.

Notification - The point in time when an alarm is received by the agency.

Alarm Processing - The time interval from the notification to the time when the dispatcher notifies the appropriate emergency responder. NFPA 1221 (2007) states that 95% of emergency call processing shall be completed within 60 seconds, and 99% of emergency call processing shall be completed within 90 seconds.

Turnout Time - The time interval between when a responder receives notice of the alarm (usually alarm tones) and the time when the responder indicates that the unit is responding, either electronically or verbally. The turnout period is the time when a crew receives an alarm, confirms the address, suits up in the proper gear, and climbs aboard the apparatus to respond. Turn out time standards were adopted in 2004 in response to NFPA 1710.

***En Route* -** The point in time when the responding company informs City Communications they are responding (out the door).

***Travel Period* -** The time interval from when the responding company reports en route to the time when the crew arrives on-scene at the emergency site.

***On-scene* -** The point in time when the responding company physically arrives at the emergency site. 'On-scene' time is confirmed by the company officer pressing the MDT 'Arrive' button, or via verbal confirmation on the mobile radio.

***Working Period* -** The time interval from when the responding company arrives on-scene to when the company goes back in service. This is the period when crews physically take steps to mitigate the event. This stage is dynamic due to various types of incidents, incident locations, time of day and year, and emergency actions performed at the scene.

***In Service* -** The point in time when a company has mitigated the event, has been re-supplied and is at full strength to respond again. TFD units use the MDT button or verbal confirmation to indicate that the company is 'In Service'.

Relationship between Fire Behavior and Response Times

Established research shows that fire progresses through various stages of development in a predictable sequence. As a result, firefighters encounter a wide range of fire conditions at each fire depending on when they arrive on scene and initiate suppression activities. Fires may be at an early stage while others may have already gained control of an entire structure. Regardless of the speed of growth or length of burn time, all fires go through the same stages of growth if the fire is allowed to continue unchecked. These stages include (in an airtight room):

- The Incipient Stage – When an ignition source raises a fuel above its ignition temperature causing it to ignite. The visible burning at this stage is still limited to the immediate area of origin. The combustion process continues to release more heat, which heats nearby objects to their ignition temperature, and they begin to burn.

- The Free Burning Stage – During the early part of this stage, the oxygen content is approximately 21%; the fire produces heat, fire gases, and smoke depending on the fuel; and the temperature may only be slightly raised. As this stage progresses, cooler air is drawn in at the bottom of the fire, heated fire gases and smoke rise vertically and then begin to bank down, the temperature rises and oxygen content decreases. This will continue until the temperature can easily exceed 1000°F, and either reaches its flashover point and then enters the smoldering stage, or goes directly into the smoldering stage without flashing over. A flashover occurs at the stage of a fire at which all surfaces and objects within a space have been heated to their ignition temperature and flame breaks out almost at once over the surface of all objects in the space.

- The Smoldering Stage – As the fire continues to burn, the temperature continues to rise, the amount of carbon monoxide and smoke continues to increase, the oxygen content continues to decrease and, as a result, the rate of combustion decreases and the fire eventually just smolders. In this phase, the oxygen content is reduced to about 15%, the room will completely fill with hot gases and smoke, the temperature can exceed 1300°F, and the volumetric expansion of gases will increase by a factor of three or more. If not disturbed, the fire will eventually become unable to sustain combustion because of oxygen deficiency and will self-extinguish, however, if oxygen is suddenly introduced a “backdraft” may occur resulting in an explosion like reaction.

Because of the varied fire conditions that can be encountered during a structure fire, a common reference point needs to be identified so that comparisons and performance objectives can be set under equal conditions. The most critical point from a life safety and property conservation point of view is the point at which flashover occurs. It is at this point that the escalation in fire conditions significantly challenges the department’s resources as well as the safety to its members. Thus, a key performance objective is to interrupt the fire’s progression prior to the point of flashover occurring. Figure 3.1 illustrates the growth or “history” of a fire event.

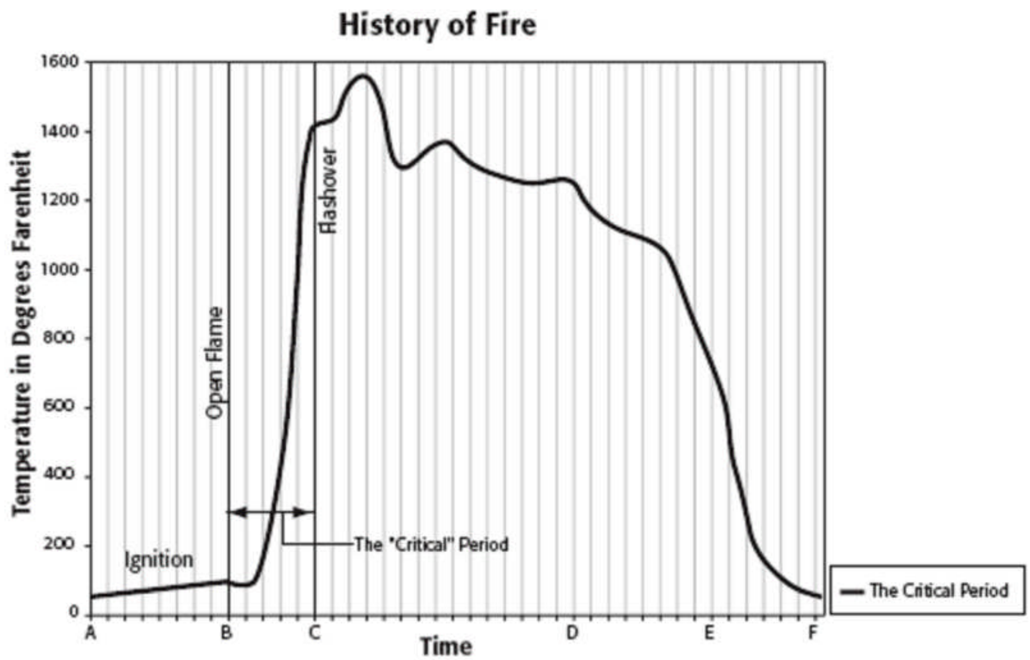

Figure 3.1. Fire growth over time representing approximately 12 minutes from time of ignition to flashover and 5 minutes from the point of open flame to flashover.

Flashover is a significant event for two reasons. First, the chance of survival for anyone (including firefighters in full protective clothing) in room when flashover occurs is unlikely. Second, a flashover creates an exponential growth in the rate of combustion, which in turn requires a greater amount of water and resources to reduce the fire's burning temperature to below its ignition temperature. Measuring the time to flashover is a function of time and temperature. While variable, the time to flashover from the time of ignition in residential and commercial occupancies with typical, modern day, hydrocarbon based contents is often 8 to 12 minutes from time of ignition. The optimum performance objective is to maintain enough staffing and equipment/apparatus, strategically located, so that the minimum acceptable response force can reach a reasonable number of fire incidents to prevent a flashover event and extinguish the fire as close to the point of its origin as possible.

Relationship between life-threatening medical conditions and response time

The Tucson Fire Department is the primary provider of EMS care for the City of Tucson. TFD provides advanced life support care with nineteen paramedic units staffed with two Arizona state certified paramedics and five paramedic assessment engine companies (PAU) staffed with one paramedic.

Similar to fire flashover, emergency medical services (EMS) use a critical point to determine the optimal time for the effective deployment of medical resources. This point in time is brain death, caused most often when a person's heart has stopped beating and oxygen can no longer reach the brain. The American Heart Association (AHA) recognizes that the brain begins to die in four to six minutes without oxygen and the survival rate drops significantly when the time exceeds four minutes to initiate defibrillation. As depicted in Figure 3.2, the survival rate is extremely low when the time to initiate defibrillation exceeds six minutes and damage is irreversible after 10 minutes. EMS interventions include early Cardio-Pulmonary Resuscitation (CPR) and electrical defibrillation. According to the AHA defibrillation is the single most important factor for survivability of the cardiac patient. Additionally, the AHA asserts that the earlier CPR is initiated, the better the chance the patient has for survival.

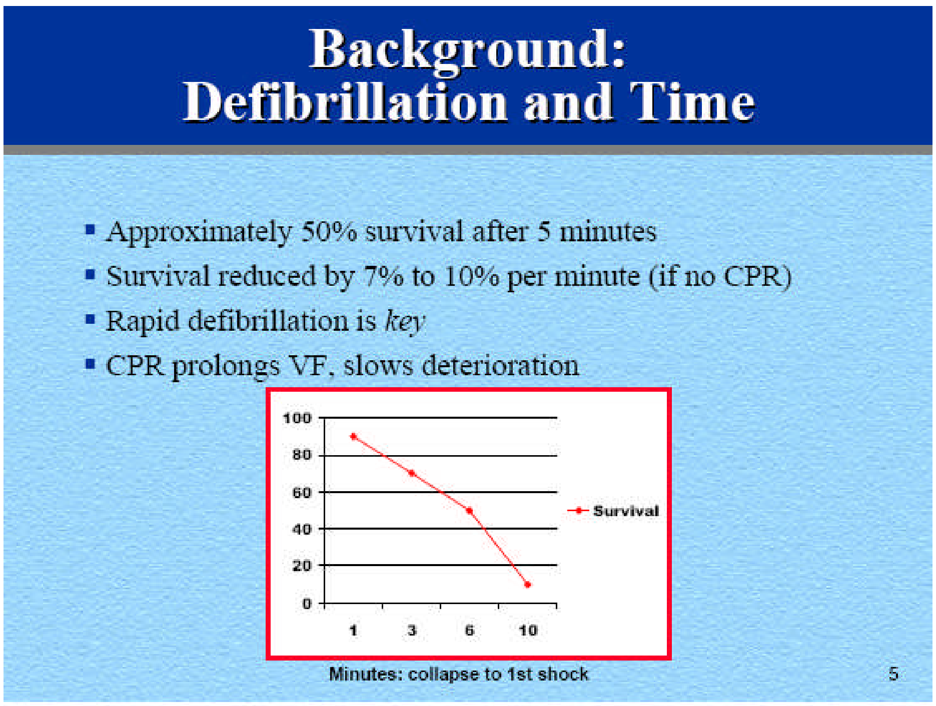

Figure 3.2. Effects of delayed CPR and defibrillation during cardiac arrest.

Setting goals and objectives that will allow the EMS patient to have access to CPR within two minutes and defibrillation within four will greatly improve the chances for the survivability of that patient. Currently, all TFD engine and ladder companies have the ability to perform CPR and defibrillation.

Call Processing Times

The 2007 edition of NFPA 1221, Standard for the Installation, Maintenance and Use of Emergency Services Communications Systems provides guidelines for call processing and dispatching. The specific standards are:

- Alarms received on emergency lines shall be answered within 15 seconds 95% of the time and within 40 seconds 99% of the time.
- Emergency call processing and dispatching shall be completed within 60 seconds 95% of the time and within 90 seconds 99% of the time.

Fire dispatching is not under the direct control of the TFD, but is rather a function of the City of Tucson General Services Department, Communications Division. Emergency dispatchers undergo ten months of training, including four weeks of didactic and nine months of supervised practical training that meets the requirements of NFPA 1061, Standard for Professional Qualifications for Public Safety Telecommunicator. This training results in Emergency Medical Dispatch, CPR and AED certifications.

Call processing is a multi-step procedure: first, a call taker receives the call (usually a 911 emergency operator) and asks the basic nature of the incident and address. The 911 emergency operator takes calls for both police and fire. The call taker then transfers the call to a fire or medical dispatcher who questions the caller, obtains sufficient information to initiate a dispatch, transfers the call to a unit dispatcher while continuing to question the caller for additional information. The unit dispatcher employs the Computer Aided Dispatch (CAD) system, which is linked to an Automatic Vehicle Location System (AVL) that identifies the units closest to the incident, to dispatch the appropriate response unit(s) to the emergency incident. For emergency medical incidents, the medical dispatcher uses the Medical Priority Dispatch System, an internationally recognized system, to further question the caller to accurately prioritize and dispatch the appropriate resources to the incident.

Reports concerning call processing time from the Communications Division have historically been presented in terms of average, a measure of central tendency. As a result, the call processing information provided for this document for FY2006-FY2008 is reported in averages. The average total call processing time for medically related incidents over the three-year period was 117 seconds. For the same period of time, the average total call processing time for non-medically related incidents was 97.9 seconds (100.1 in FY2008). When reporting the total response time, the call processing average times will be added to the other response factors that are reported in percentiles. Although not a perfect system, it will provide a measurement of performance that is consistent throughout the document.

The 117 second call processing time can be considered to be the most conservative figure. Table 3.1 breaks down the separate events during the call processing procedure. Because the Medical Priority Dispatch System is made up of set, pre-determined questions covering a wide variation of potential medical issues, it often takes longer to process medical calls than fire related calls. The call processing times have been increasing incrementally over the last three years. This increase is attributed to the additional questions added to the Emergency Medical Dispatcher caller interview, and to the significant number of people who were in training for the past year.

Call Processing Event N-227,973	**Time in Seconds**					
	FY2006		**FY2007**		**FY2008**	
	Med	**Fire**	**Med**	**Fire**	**Med**	**Fire**
Average answering time for 911 calls	3	3	4	4	4	4
Average talk time for 911 operator and transfer to the dispatcher	38	38	38	38	38	38
EMD Talk Time (Emergency Medical Dispatcher talking to caller to initiation of alarm tones*)	72.5	53	75.2	57.7	75.7	58.1
Dispatch tones/voicing	15	15	15	15	15	15
Total Call Processing Time	**128.5**	**109**	**132.2**	**114.7**	**132.7**	**115.1**

Table 3.1. City of Tucson General Services Department, Communications Division Average call processing time including dispatch tones and dispatcher voicing the dispatch over the radio for FY2006 through FY2008.

An upgrade to the reporting software used by the Communications Division that will provide call processing information in percentiles has been requested and is due for installation by the fall of 2008. Future SORC documents will report call processing information in percentiles.

NFPA 1710/1720 and Response Times

In 2001, the National Fire Protection Association adopted the first edition of NFPA 1710, Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments. Updated in 2004, the standard outlines an organized approach to define levels of service, deployment capabilities, and staffing levels for career fire departments.

More specifically, NFPA 1710 provides standard definitions for fire apparatus, personnel assigned, procedural guidelines within which they operate, and staffing levels needed to accomplish specific tasks on arrival at an incident.

NFPA 1710 states that fire departments shall establish a performance objective of not less than 90% for each of the following response time objectives:

- One minute for turnout time.
- Four minutes or less travel time for the arrival of the first arriving engine company at a fire suppression incident and/or eight minutes or less for the arrival of a full alarm assignment at a fire suppression incident.
- Four minutes or less travel time for the arrival of a unit with first responder, or higher level of capability at an emergency medical incident.
- Eight minutes or less travel time for the arrival of an advanced life support unit at an emergency medical incident.

NFPA 1720, although specifically developed to address volunteer fire departments, does provide guidelines for response times in a more suburban and rural setting. This standard outlines the following response guidelines for assembling a full alarm assignment:

- Suburban demand zone response time – 10 minutes or less 80% of the time
- Rural demand zone response time – 14 minutes or less 80% of the time

As the City of Tucson encompasses all three land use types (urban/industrial, suburban, and rural/isolated), the Tucson Fire Department utilizes the both NFPA 1710 and NFPA 1720 to guide its response times goals.

Code 2/Code 3 Responses

Code 2 is a response without the use of red lights and siren, while Code 3 is a response with emergency lights and siren. The purpose of a Code 3 response is to allow a responding unit to maneuver through traffic congestion in a safe and efficient manner. ARS § 28-775 requires roadway traffic and pedestrians to yield to an emergency vehicle, and ARS § 28-624 exempts the driver of an authorized emergency vehicle with emergency equipment in operation from the general rules of the road, however, the driver of an emergency vehicle is never relieved from the duty to drive with due regard for the safety of all persons and/or property.

A number of studies have indicated that an emergency response using warning devices is more dangerous than a response in which the vehicle flows normally with traffic. As a result, in 2006 the TFD reviewed the types of non-medically related incidents that it responds to and determined those that may not require an emergency response. As a result of this review, nearly 50% of the call types that were previously responded to Code 3 were downgraded to a Code 2 response. Company officers may upgrade the response if subsequent information indicates that it is necessary. In establishing this new response policy, total response times were understandably increased, however, there has been no indication that service delivery, as evidenced by few incident upgrades, has been negatively affected.

Alpha Truck

Following a successful pilot program in FY2006, less serious medical care and other assistance is provided by TFD emergency medical technicians via a pick-up truck rather than more expensive ambulances or larger fire vehicles. The purpose of this program is to not just take some of the response burden from the engine and ladder companies, but to reduce the number of calls going through the 911 system by providing social service referrals and assistance, as needed. By the end of FY2009, four Alpha trucks should be in service, responding to an estimated 10,000 calls.

As the vast majority of calls that the Alpha trucks respond to are non-emergency incidents, they respond to them in a Code 2 mode. Further, these calls are 'stacked' in a dispatch queue for as long as 20 minutes. If they cannot respond to the call within that 20 minute time frame, another unit is dispatched to the call.

Response Times

The following tables (Tables 3.2 to 3.13) describe the TFD's actual response time performance for Fiscal Year 2008. The four factors analyzed include Alarm Processing Time, Dispatch Tones/Voicing Time, Turnout Time and Travel Time. As indicated earlier, alarm processing time and dispatch tones/voicing time are currently recorded as averages. For the purpose of this report, the highest average will be used, medically related calls for FY2008 (117.7). These averages are incorporated in these tables. These average times are being added to the two other variables which have been recorded as percentiles to determine total response times. Times are recorded in seconds.

Code 2 Incidents (Medical and Non-Medical)

(Medical Alpha, Stranded in water, Standing water, CO alarm, Elevator, Invalid assist, Ring stuck on finger, Bee swarm, TPD assist, Potential suicide from roof, Fire out, Odor, Wire down, Broken pipe, Lightning strike)

N=14,575	70%	80%	90%
Alarm Processing Time	117.7	117.7	117.7
Dispatch Tones/Voicing	15	15	15
Turnout Time	44	50	57
Travel Time	306	333	367
Total Response Time	482.7 (8:03 minutes)	515.7 (8:36 minutes)	556.7 (9:17 minutes)

Table 3.2. Tucson Fire Department response data for FY2008 – Code 2 incidents.

N=6,872	70%	80%	90%
Alarm Processing Time	117.7	117.7	117.7
Dispatch Tones/Voicing	15	15	15
Turnout Time	43	48	54
Travel Time	311	344	384
Total Response Time	486.7 (8:07 minutes)	524.7 (8:45 minutes)	570.7 (9:31 minutes)

Table 3.3. Tucson Fire Department response data for FY2008 – Urban/Industrial Demand Zone Code 2 incidents.

N=7,401	70%	80%	90%
Alarm Processing Time	117.7	117.7	117.7
Dispatch Tones/Voicing	15	15	15
Turnout Time	46	52	58
Travel Time	299	383	413
Total Response Time	477.7 (7:58 minutes)	567.7 (9:28 minutes)	603.7 (10:04 minutes)

Table 3.4. Tucson Fire Department response data for FY2008 – Suburban Demand Zone Code 2 incidents.

N-302	70%	80%	90%
Alarm Processing Time	117.7	117.7	117.7
Dispatch Tones/Voicing	15	15	15
Turnout Time	48	53	60
Travel Time	352	376	404
Total Response Time	532.7 (8:53 minutes)	561.7 (9:22 minutes)	596.7 (9:55 minutes)

Table 3.5. Tucson Fire Department response data for FY2008 – Rural/Isolated Demand Zone Code 2 incidents

Code 3* Incidents

(ALS, Structure fire, Vehicle fire)

N=19,485	70%	80%	90%
Alarm Processing Time	117.7	117.7	117.7
Dispatch Tones/Voicing	15	15	15
Turnout Time	33	38	43
Travel Time	169	181	195
Total Response Time	334.7 (5:35 minutes)	351.7 (5:52 minutes)	370.7 (6:10 minutes)

Table 3.6. Tucson Fire Department response data for FY2008 – all Code 3 incidents.
***Code 3 is a response with emergency lights and siren, Code 2 is a response without lights and siren.**

N=8,207	70%	80%	90%
Alarm Processing Time	117.7	117.7	117.7
Dispatch Tones/Voicing	15	15	15
Turnout Time	32	37	42
Travel Time	161	172	186
Total Response Time	325.7 (5:26 minutes)	341.7 (5:42 minutes)	360.7 (6:01 minutes)

Table 3.7. Tucson Fire Department response data for FY2008 – Urban/Industrial Demand Zone Code 3 incidents.

N=10,631	70%	80%	90%
Alarm Processing Time	117.7	117.7	117.7
Dispatch Tones/Voicing	15	15	15
Turnout Time	34	38	43
Travel Time	174	186	200
Total Response Time	340.7 (5:41 minutes)	356.7 (5:57 minutes)	375.7 (6:16 minutes)

Table 3.8. Tucson Fire Department response data for FY2008 – Suburban Demand Zone Code 3 incidents.

N=647	70%	80%	90%
Alarm Processing Time	117.7	117.7	117.7
Dispatch Tones/Voicing	15	15	15
Turnout Time	37	42	47
Travel Time	215	238	266
Total Response Time	384.7 (6:25 minutes)	412.7 (6:53 minutes)	445.7 (7:26 minutes)

Table 3.9. Tucson Fire Department response data for FY2008 – Rural/Isolated Demand Zone Code 3 incidents.

EMSALS

(Paramedic unit only)

N=17,212	70%	80%	90%
Alarm Processing Time	117.7	117.7	117.7
Dispatch Tones/Voicing	15	15	15
Turnout Time	43	48	54
Travel Time	205	221	241
Total Response Time	380.7 (6:21 minutes)	401.7 (6:42 minutes)	427.7 (7:08 minutes)

Table 3.10. Tucson Fire Department response data for FY2008 – all EMSALS.

N=7,210	70%	80%	90%
Alarm Processing Time	117.7	117.7	117.7
Dispatch Tones/Voicing	15	15	15
Turnout Time	42	47	53
Travel Time	191	206	225
Total Response Time	365.7 (6:06 minutes)	385.7 (6:26 minutes)	410.7 (6:51 minutes)

Table 3.11. Tucson Fire Department response data for FY2008 – Urban/Industrial Demand Zone EMSALS.

N=9,446	70%	80%	90%
Alarm Processing Time	117.7	117.7	117.7
Dispatch Tones/Voicing	15	15	15
Turnout Time	43	48	54
Travel Time	211	227	247
Total Response Time	386.7 (6:27 minutes)	407.7 (6:48 minutes)	433.7 (7:14 minutes)

Table 3.12. Tucson Fire Department response data for FY2008 – Suburban Demand Zone EMSALS.

N=556	70%	80%	90%
Alarm Processing Time	117.7	117.7	117.7
Dispatch Tones/Voicing	15	15	15
Turnout Time	48	54	60
Travel Time	354	404	454
Total Response Time	534.7 (8:55 minutes)	590.7 (9:51 minutes)	646.7 (10:47 minutes)

Table 3.13. Tucson Fire Department response data for FY2008 – Rural/Isolated Demand Zone EMSALS.

Tables 3.14 to 3.25 look at multiple unit responses for working structure fires, hazardous materials incidents and technical rescue incidents for FY2006 through FY2008. A 'working incident' is one where each responding unit performed some essential task. These tables look at first arriving unit response times as well as how long it took to assemble the full complement of primary first alarm units necessary to complete, or at least initiate, the essential tasks required of the particular incident. The primary first alarm units include two engines, one ladder, one paramedic, one battalion chief and one EC captain. The RIC (Rapid Intervention Crew) units, one engine and one EC captain, were not included in this reporting. The RIC units are initially dispatched to respond in a 'normal traffic' mode. If information received en route indicates that the incident is a probable working incident, the RIC units are upgraded to an 'emergency' response mode, including red lights and siren.

Response times for Tables 3.14 to 3.25 include turnout time and time of travel. They are reported in minutes.

Working Structure Fires

N = 573	70%	80%	90%
Response Time – First Arriving	3:15	3:28	3:42
Response Time – 2 Eng, 1 Lad, 1 PM, 1 BC, 1 EC	9:25	9:58	10:48

Table 3.14. Tucson Fire Department response data for FY2006 through FY2008 – all working structure fires.

N = 305	70%	80%	90%
Response Time – First Arriving	3:06	3:18	3:31
Response Time – 2 Eng, 1 Lad, 1 PM, 1 BC, 1 EC	9:19	9:51	10:32

Table 3.15. Tucson Fire Department response data for FY2006 through FY2008 – Urban/Industrial Demand Zone working structure fires.

N = 252	70%	80%	90%
Response Time – First Arriving	3:24	3:37	3:50
Response Time – 2 Eng, 1 Lad, 1 PM, 1 BC, 1 EC	9:23	9:55	10:36

Table 3.16. Tucson Fire Department response data for FY2006 through FY2008 – Suburban Demand Zone working structure fires.

N = 16	70%	80%	90%
Response Time – First Arriving	4:06	4:19	4:40
Response Time – 2 Eng, 1 Lad, 1 PM, 1 BC, 1 EC	12:58	14:01	14:30

Table 3.17. Tucson Fire Department response data for FY2006 through FY2008 – Rural/Isolated Demand Zone working structure fires.

The initial response for special operations (hazardous materials and technical rescue) incidents normally involve some level of specialty units in addition to the normal response. These units may or may not respond with red lights and siren. In addition, with the exception of the first due engine company, the response to special operations incidents is based on the closest available units trained to respond to that particular type of incident, not just the closest available fire unit. All TFD members are trained at least to the First Responder level in each of the special operations disciplines and are capable of initiating critical tasks prior to the arrival of the specialty unit(s).

Working Hazardous Materials Incidents

N = 61	70%	80%	90%
Response Time – First Arriving	4:26	4:46	5:09
Response Time – 2 Eng, 1 Lad, 1 PM, 1 BC, 1 EC	9:39	10:18	11:03

Table 3.18. Tucson Fire Department response data for FY2006 through FY2008 – all working hazardous materials incidents.

N = 41	70%	80%	90%
Response Time – First Arriving	4:18	4:39	5:04
Response Time – 2 Eng, 1 Lad, 1 PM, 1 BC, 1 EC	9:07	9:41	10:19

Table 3.19. Tucson Fire Department response data for FY2006 through FY2008 – Urban/Industrial Demand Zone working hazardous materials incidents.

N = 19	70%	80%	90%
Response Time – First Arriving	4:29	4:48	5:08
Response Time – 2 Eng, 1 Lad, 1 PM, 1 BC, 1 EC	10:51	11:39	12:32

Table 3.20. Tucson Fire Department response data for FY2006 through FY2008 – Suburban Demand Zone working hazardous materials incidents.

N = 1	
Response Time – First Arriving	6:57
Response Time – 2 Eng, 1 Lad, 1 PM, 1 BC, 1 EC	13:39

Table 3.21. Tucson Fire Department response data for FY2006 through FY2008 - Rural/Isolated Demand Zone working hazardous materials incidents.

Working Technical Rescue Incidents

N = 13	70%	80%	90%
Response Time – First Arriving	3:48	4:13	4:38
Response Time – 2 Eng, 1 Lad, 1 PM, 1 BC, 1 EC	14:22	15:05	17:14

Table 3.22. Tucson Fire Department response data for FY2006 through FY2008 – Working technical rescue incidents.

N = 6	70%	80%	90%
Response Time – First Arriving	3:54	4:21	4:41
Response Time – 2 Eng, 1 Lad, 1 PM, 1 BC, 1 EC	15:11	17:13	17:13

Table 3.23. Tucson Fire Department response data for FY2006 through FY2008 – Urban/Industrial Demand Zone working technical rescue incidents.

N = 4	70%	80%	90%
Response Time – First Arriving	3:42	3:56	4:22
Response Time – 2 Eng, 1 Lad, 1 PM, 1 BC, 1 EC	17:45	17:45	20:57

Table 3.24. Tucson Fire Department response data for FY2006 through FY2008 – Suburban Demand Zone working technical rescue incidents.

N = 3	70%	80%	90%
Response Time – First Arriving	3:59	4:25	5:18
Response Time – 2 Eng, 1 Lad, 1 PM, 1 BC, 1 EC	10:45	10:45	12:18

Table 3.25. Tucson Fire Department response data for FY2006 through FY2008 – Rural/Isolated Demand Zone working technical rescue incidents.

Tucson Fire Department Standards of Response Coverage Statements
The Tucson Fire Department has historically maintained the following response time goals:

1. Arrive at all emergency scenes within five minutes of dispatch 90% of the time.
2. Arrive at scene within eight minutes of dispatch for advanced life support response 90% of the time. The State of Arizona benchmark is nine minutes 90% of the time.
3. Provide cardiopulmonary resuscitation for citizens suffering non-injury cardiac arrest with 20% of patients arriving at hospital with pulse after full resuscitation.
4. Treat Advanced Life Support patients on scene in a timely manner.

    - 90% of ALS medical transports <25 minutes
    - 99% of ALS trauma transports <20 minutes
    - Minimize post transport time out of service.
    - 60% of transports <30 minutes

Based on an analysis of the last three fiscal years' response data, these goals are being revised and the TFD is adopting the following response time related goals:

- Total call processing time (alarm processing time + dispatch tones/voicing time of 15 seconds) of 105 seconds for all non-medical calls and 130 seconds for medical calls. Until better reporting software is implemented, this will be reported as an average. Once implemented, the goal will be based on performance 90% of the time.

- Turnout time of 60 seconds for all calls 90% of the time.

- A maximum initial response time (turnout time + travel time) for all emergency calls (red light and siren response mode) of 5 minutes within the urban/industrialized demand zone or the suburban demand zone and 6 minutes for the rural/isolated demand zone 90% of the time.

- A maximum initial response time for all non-emergency calls (normal traffic response mode) of 12 minutes within the city limits 90% of the time.

The following describes the EMSALS response goals city wide:

- For an ALS level emergency medical incident, a response that results in a minimum of two state certified paramedics arriving within 8 minutes of the time of dispatch (turnout time + travel time) with advanced life support capability 90% of the time.

- Treat Advanced Life Support patients on scene in a timely manner.
    - 90% of ALS medical transports <25 minutes
    - 99% of ALS trauma transports <20 minutes

- Minimize post transport time out of service.
    - 60% of transports <30 minutes

The following describes the structure fire response goals for each demand zone:

- For a structure fire in either the urban/industrialized demand zone or the suburban demand zone, a response that results in a minimum of twenty firefighters, including an incident commander, with the first unit arriving within 4 minutes of the time of dispatch (turnout time + travel time) and the balance within 10:30 minutes 90% of the time.

- For a structure fire in a rural/isolated demand zone, a response that results in a minimum of twenty firefighters, including an incident commander, with the first unit arriving within 5 minutes of the time of dispatch and the balance within 15 minutes 90% of the time.

The following describes the hazardous materials incident response goals for each demand zone:

- For a hazardous materials incident in an urban/industrialized demand zone, a response that results in a minimum of 23 firefighters, including an incident commander, with the first unit arriving within 5 minutes of the time of dispatch (turnout time + travel time) and the balance within 11 minutes 90% of the time.

- For a hazardous materials incident in a suburban demand zone, a response that results in a minimum of 23 firefighters, including an incident commander, with the first unit arriving within 5 minutes of the time of dispatch and the balance within 13 minutes 90% of the time.

- For a hazardous materials incident in a rural/isolated demand zone, a response that results in a minimum of 23 firefighters, including an incident commander, with the first unit arriving within 6 minutes of the time of dispatch and the balance within 14 minutes 90% of the time.

The following describes the technical rescue incident response goals for each demand zone:

- For a technical rescue incident in an urban/industrialized demand zone, a response that results in a minimum of 23 firefighters, including an incident commander, with the first unit arriving within 5 minutes of the time of dispatch (turnout time + travel time) and the balance within 15 minutes 90% of the time.

- For a technical rescue incident in a suburban demand zone, a response that results in a minimum of 23 firefighters, including an incident commander, with the first unit arriving within 5 minutes of the time of dispatch and the balance within 18 minutes 90% of the time.

- For a technical rescue incident in a rural/isolated demand zone, a response that results in a minimum of 23 firefighters, including an incident commander, with the first unit arriving within 6 minutes of the time of dispatch and the balance within 20 minutes 90% of the time.

Efforts are continually made to shorten time in each of the steps. New technology, training and improved equipment are the most common avenues, however, some are difficult to control or to lessen further. For example, state statute and industry standards determine appropriate travel speeds and travel time can only be reduced through improvement of street layout designs, station location and adaptive response units.

<u>SECTION FOUR</u>
On-Scene Operations, Critical Tasking, and Effective Response Force

This section describes the methodology for determining staffing levels for different incident types, the number of units needed, and the duties that must be performed to mitigate the incident effectively and efficiently.

On-scene Operations

The Tucson Fire Department's risk management policy has established the following guidelines to provide direction to on-scene personnel when evaluating on-scene conditions and how to respond to those conditions:

- We will risk our lives, in a highly calculated and controlled manner, to protect a savable human life.
- We will risk our lives to a lesser extent, in a highly calculated and controlled manner, to protect savable property.
- We will not risk our lives at all to protect lives or property that is already lost.

Structure Fires

The variety of fireground factors, including the building and occupancy type, size and intensity of the fire, and life hazards, determine the tasks required to deal with the incident as well as the level of risk that will be taken in completing those tasks. These tasks are interrelated but can be separated into two basic types, fire suppression and life safety. Fire suppression tasks are those related to extinguishing the fire. Life safety tasks are those related to finding trapped victims and removing them from the building.

Fire suppression tasks, specifically as they apply to the application of water, can be accomplished with hand held hoses or master streams. Each 1¾" hose line requires a minimum of two firefighters. A 1¾" hose line can flow 150 gallons per minute (GPM), so when these lines are used the fire flow is 75 GPM per firefighter. The 2½" hose line can flow 250 GPM and requires a minimum of two or three firefighters to effectively manipulate it, yielding a flow of 75 to 125 GPM per firefighter. Master streams can flow from 500 to 1000 GPM each. Fewer firefighters are required to operate these large caliber streams because they are fixed to the apparatus.

The decision to use hand lines or master streams depends upon the stage of fire and threat to life safety. If the fire is in a pre-flashover stage, generally an offensive fire attack strategy is engaged in which firefighters take smaller caliber hand lines to the interior of the building. The hand lines are used to attack the fire and shield trapped victims until they can be removed from the building. If the fire is in its post-flashover stage and the fire has extended beyond the capacity or mobility of hand lines, or the structural damage is a threat to the firefighters' life safety, then a defensive strategy is engaged. With a defensive strategy, the structure is presumed lost, all firefighters are removed from the building and master streams are employed to keep the fire from advancing to surrounding buildings.

The life safety tasks are based upon the number of occupants, their location, their status (awake vs. sleeping), and their ability to take self-preserving action. For example, ambulatory adults need less assistance than non-ambulatory. The elderly and small children usually require more assistance.

The Tucson Fire Department performs aggressive offensive attacks whenever possible, with the objective of first putting a hose line between potential victims and the fire and contain the fire to the room of origin. The importance of this rapid, interior fire attack and its relationship to life safety is scene in Figure 4.1.

Extension	Civilian Deaths	Civilian Injuries	Dollar Loss Per Fire
Confined to the room of origin	2.32	35.19	3,185
Beyond the room but confined to the floor of origin	19.68	96.86	22,720
Beyond the floor of origin	26.54	63.48	31,912

Figure 4.1. Fire extension in residential structures 1994-1998. Rate per 1000 fires. (Source: NFPA 1710)

Critical Tasks

Critical tasks are those tasks that must be conducted in a timely manner by responders in order to effectively manage an emergency incident.

<u>Structure Fires – Critical Tasks</u>

NFPA 1710 outlines critical tasks that must be completed by an initial response to a structure fire. The basic goal of structural firefighting is to control the fire before it reaches the flashover stage. The critical tasks that must be accomplished by the initial response forces at a structure fire are identified below. Dependent on the situation, these tasks may be performed sequentially or concurrently.

- *Attack Line* – This task involves the deployment of a 1¾" hose line that produces 150 GPM and is usually handled by a minimum of two firefighters, or a 2½" hose that produces 250 GPM and is handled by 2 or 3 firefighters. Each engine carries a set of attack lines that are either pre-connected to the pump, folded on the hose bed, or in a special pack for carrying into high-rise buildings. The selection of which attack line to use depends on the type of structure, the distance to the seat of the fire, and the stage of the fire. The pre-connected lines are the fastest to use but are limited to fires within 200 feet of the engine. When attack lines are needed beyond this limit, the hose bed lines or high-rise lines are used. A 2½" attack line may be used when the fire is already beyond the flashover stage and threatens an unburned portion of a structure. Due to their size and weight, 2½" attack lines are seldom used in interior fire attacks.

- *Search and Rescue* – This task involves the search for living victims and their removal from danger while the attack crew moves between the victims and the fire for protection. A two-person search and rescue crew is normally sufficient for most moderate risks structures, but more crews are required in multi-story buildings or structures with people who are not capable of self-preservation.

- *Ventilation Crew* – This task involves the opening of a horizontal or vertical ventilation channel when the attack crew is ready to enter the building. Ventilation tasks require two or more firefighters for effective completion. Ventilation removes superheated gases and obscuring smoke, preventing flashover and allowing attack crews to see and work closer to the seat of the fire. It also gives the fire an exit route so the attack crew can "push" the fire out the opening they choose and keep it away from endangered people or unburned property. Ventilation must be closely timed with the fire attack. If it is performed too soon, the fire will get additional oxygen and grow. If performed too late, the attack crew cannot push the fire in the desired direction. Instead, the gases and smoke will be forced back toward the firefighters and their entry point, endangering themselves, as well as any victims and unburned property they may be protecting.

- *Back-up Line* – This task involves the deployment of a 1¾" or 2½" hose line that is taken in behind the attack crew to cover their path of egress or support the attack crew. This task requires a minimum of two firefighters if a 1¾" line is used. A 2½" hose line may be used in lieu of a 1¾" line if the situation requires a larger volume of water at the point of attack.

- *Rapid Intervention Crew (RIC)* – This task involves the staging of firefighters in a position of tactical advantage, equipped with rescue tools and a 1¾" hose line, ready to enter the structure and perform search and rescue if something goes wrong. This establishment of a rescue crew is an OSHA requirement. Current procedures call for a minimum of four firefighters to assume this role as soon as possible, generally with the arrival of a third engine company dispatched for this purpose.

- *Exposure Line* – This task involves the deployment of a 1¾" attack line to prevent fire expansion. This 'exposure' line requires a minimum of two firefighters to deploy and use. An exposure line can protect internal exposures, such as the floor above the fire in multi-story buildings or adjacent occupancies within the building. Exposure lines may also be used externally to protect nearby structures from igniting from the radiant heat. In situations where the heat release is great, or structures are built close together, a 2½” hose line or master stream would be used. If a 2½” hose line is used, the staffing requirement is increases.

- *Pump Operator* – This involves one firefighter to effectively operate the engine’s water delivery system. The pump operator monitors water pressure and flow on each hose line and ensures that the apparatus is operating within designed parameters. The pump operator also completes the hose hookups to the correct discharges and completes the water supply hookup to the correct intake. If hydrant location allows, the pump operator may also connect the supply line to the hydrant without assistance, although this task is usually assigned to an additional firefighter.

- *Water Supply* – An engine has about four minutes of water if one 1-3/4 inch line is flowing at full capacity. In order to maintain a continuous flow of water for longer periods of time, the engines pump must be connected to a hydrant. This task requires one or two firefighters to deploy the large diameter (5”) hose between the engine and the nearest hydrant before the engine's water tank runs dry.

- *Incident Command* – The successful mitigation of any emergency incidents requires the implementation of an effective command structure. This task involves one firefighter who coordinates the attack, evaluates results and redirects the attack as necessary, arranges for more resources, and monitors conditions that might jeopardize crew safety. The Incident Commander is generally located outside of the structure and is assisted with a Status Officer.

- *Utilities* – This task involves the assignment of at least one firefighter to secure natural gas, electrical supply and water to the affected structures before interior firefighters open any concealed spaces, such as walls or attic spaces.

- *Ladder operations* - If vertical ventilation is performed, at least one firefighter, but more usually two, is needed to set-up the aerial ladder and a ground ladder to provide access to the roof of the structure.

- *EMS/Rehabilitation* – This task involves the assignment of at least one firefighter, but more usually two, to establish a treatment and rehabilitation sector to prepare for any victims found and any firefighters who are injured or physically drained. This is a common occurrence in the Arizona summers.

- *Safety Officer* – This task involves the assignment of one firefighter dedicated to the exterior of structure with the sole responsibility of monitoring firefighter and scene safety.

- *Status Officer* – This task involves the assignment of one firefighter to assist in the Incident Commander with tracking units and incident planning and management.

Table 4.1 identifies the critical tasks and the number of firefighters required to complete them for a structure fire in moderate risk and high risk occupancies:

Critical Tasks	Moderate Risk Occupancy	High Risk Occupancy
Incident Command	1	1
Initial Fire Attack/ Primary Search	5	5
Pump Operations	2	3
Backup Line/Exposure Protection	2	7
RIC	4	4
Utilities	1	1
Safety	1	1
Status	1	1
Ventilation	3	3
Command Support		1
Rehabilitation		2
Ladder Operations		3
Total	**20**	**32**

Table 4.1. Critical tasks and the number of firefighters required to complete them for a fire in moderate risk and high risk occupancies.

As the fire scene is unpredictable in many ways, it is not always possible to predict how many firefighters it will take to accomplish the required tasks. If the incident progresses beyond the capabilities of the initial response, later arriving chief officers provide command support for such tasks as planning, logistics and administrative positions. Additional firefighting personnel may reinforce the points of attack, provide relief or staff additional support positions. The quantities of personnel and equipment necessary to accomplish the tasks listed in Table 4.1 will vary with a number of factors, including:

- delayed response;
- building construction;
- number of occupants;
- physical and emotional condition of occupants;
- extent of fire upon arrival (flashover);
- built-in fire protection;
- area of fire involvement
- firefighter or civilian injuries
- equipment failure

Critical tasking represents the minimum amount of firefighters needed early during the fire scene. There are several other tasks that must be performed prior to termination of the scene such as salvage, overhaul and fire investigation. Additional units may be summoned for these tasks increasing the number of firefighters on-scene.

Emergency Medical Services - Critical Tasks

The Tucson Fire Department responded to 66,919 medical calls in FY2008. These calls ranged in scope from basic level evaluations for the sick and injured, to more advanced evaluation, treatment, and transportation of the critically ill and injured. TFD provides advanced life support (ALS) first response services with eighteen paramedic units, each staffed by two paramedic/firefighters, and eleven paramedic assessment engine companies (PAUs), each staffed with four personnel, one of whom is a paramedic/firefighter. All commissioned personnel below the rank of Battalion Chief are certified to at least the Emergency Medical Technician-Basics (EMT).

Medical direction for TFD is provided through a contractual agreement with the University Medical Center (UMC). Medical direction is provided by means of offline (standing administrative orders) and online (radio telemetry) medical control. UMC provides administrative oversight as it pertains to matters of certification. Medical oversight is provided both operationally and administratively through the use of EMS Captains (EC) who are under the direction and supervision of a Battalion Chief. Four EC are assigned to each of three shifts to oversee operational issues and one is assigned in a 40 hour administrative capacity to the Medical Administration Section.

TFD provides ambulance transportation for patients requiring advanced life support. Patients requiring a lesser level of care (BLS) are transported by Southwest Ambulance, a commercial ambulance service. Both TFD and Southwest Ambulance operate within certain boundaries according to their Certificate of Necessity (CON) as established by the Arizona Department of Health Services. All Southwest Ambulance transports are staffed with a minimum of at least two EMT-Basic personnel.

The City of Tucson General Services Division provides dispatching services for the department. The dispatch center utilizes priority medical dispatch procedures. All dispatchers are trained to triage every medical call into four separate response types based on the level of risk for the patient. Some of the triage factors are location and extent of injury or pain, level of consciousness, and cardiac and respiratory status. The response types are labeled as either Alpha, Bravo, Charlie, or Delta with Alpha level calls being the lowest priority/risk and Delta calls being the highest priority/risk. These call types are further broken down into more specific categories in order to determine the appropriate response configuration.

Alpha level calls receive a single BLS unit, code-2 (without lights and sirens) response.

- *Bravo level* calls receive single BLS unit, code-3 (with lights and sirens) response.
- *Charlie level* calls receive a single ALS unit, code-3 response.
- *Delta level* calls are the highest priority and receive a multi-unit, code-3 response. The minimum response to a Delta call is a BLS unit and a transport capable ALS unit.

All dispatchers are given the ability to alter response levels based on the information being received. In addition, company officers may also request additional units, alter the Code-2/Code-3 response level, or cancel any units based on information received through dispatch or at the scene.

The Tucson Fire Department participates in the Metropolitan Medical Response System (MMRS) for southern Arizona. This system was established in order to effectively respond to and mitigate large scale medical emergencies such as natural and manmade disasters. Mass casualty response units are housed at Fire Stations 6 and 7 as part of the MMRS; this equipment would respond with a full medical alarm at the time of an MMRS response request. Tables 4.2 and 4.3 outline the critical tasks for single patient as well as multi and mass casualty events.

Critical Task	Cardiac Arrest	Multi System Trauma
EKG monitor/lifting* and cardiac defibrillation	1	1
Airway management	1	1
Chest compressions	1	--
IV/Pharmacology	1	1
Bandaging/splinting/packaging/lifting*	1**	2
Documentation/lifting*	1*	1
Total	**6**	**6**

Table 4.2. – EMS critical tasks – single patient.

* lifting tasks will be accomplished by personnel who have completed their tasks or whose tasks can be interrupted for lifting the patient.

** also assists with IV prior to packaging/lifting tasks

Critical Task	Multi-Casualty 6-10 patients	Mass Casualty >10 up to 50 patients
Incident command	1	1
Med group supervisor	1	1
Safety officer**	1	1
Triage***	2	2 - 5
Treatment	4 - 6	6 - 20
Transportation	3 – 5	5 – 10
MedCom****	1	1
Litter bearers	3 - 5	5 - 10
Site Control	PD	PD
Air operations	4	4
Total	**20 - 26**	**26 - 53**

Table 4.3. – EMS - Multi and mass casualty event critical tasking.
***** Assumes a roughly even distribution of minor, delayed, and immediate patients.
** Additional assistant safety officers assigned as needed.
*** Triage personnel to be reassigned to treatment following completion of triage operations.
**** MedCom = Medical Communications, coordinates patient transport with area hospitals.

Special Operations - Critical Task

The Tucson Fire Department currently maintains three types of teams that comprise the Special Operations Division in various locations across the city. TFD has two Hazardous Materials Control Teams at Fire Stations #1 and #17, one Technical Rescue Team (TRT) housed at Fire Station #22 and two Rapid Response Teams (RRT) located at Fire Stations #19 and #20. The Rapid Response Teams are staffed with personnel who are trained in both hazardous materials and technical rescue operations.

The Technical Rescue Team and the two Rapid Response Teams are staffed with personnel who are trained to mitigate rope or high angle rescues, swift water rescues, trench collapse rescues, confined space rescues and structural collapse rescues. Table 4.4 represents the critical tasks and personnel needs and Table 4.5 represents the apparatus requirements to mitigate these types of emergencies. The Heavy Rescue, RRT Squad Vehicles & the Structural Collapse Support Truck are not permanently staffed and are brought to the scene by members assigned to the TRT/RRT Suppression companies. Both the TRT and RRTs have 2 paramedics assigned to each team.

The Hazardous Material Team and the Rapid Response Teams are staffed with personnel certified as Hazardous Material Technicians who are responsible for controlling hazardous material incidents. Table 4.6 represents the critical tasks and personnel needs and Table 4.7 represents the apparatus requirements to control these types of emergencies. The actual number of technical rescue team members or hazardous materials team members requested will depend on need and complexity of the incident.

Rope/High Angle		Swift Water	
Critical Task	**Personnel**	**Critical Task**	**Personnel**
IC	1 Ops	IC	1 Ops
Safety	1 TRT	Safety	1 TRT
Technical Sector Officer	1 TRT	Technical Sector Officer	1 TRT
Rescuers/Recon	2 TRT	Downstream Spotters	6 TRT
Edge Persons	2 TRT	System Riggers	6 TRT
System Riggers/Haul Team	7 TRT	Boat Team	5 TRT
Belay Line Staffers	2 TRT		
Subtotal: TRT Operations Personnel	*16*	*Subtotal: TRT Operations Personnel*	*20*
EMS	2 Ops	EMS	2 Ops
Lights	1 Ops	Upstream Spotters	2 Ops
Rehab	1 Ops	Decon/HM	2 HM/Ops
		Rehab	1 Ops
Subtotal: Support Personnel	*4*	*Subtotal: Support Personnel*	*7*
TOTAL	**20**	**TOTAL**	**27**

Trench		Confined Space	
Critical Task	**Personnel**	**Critical Task**	**Personnel**
IC	1 Ops	IC	1 TRT
Safety	1 TRT	Safety	1 TRT
Technical Sector Officer	1 TRT	Technical Sector Officer	1 TRT
Shore/Retrieval System Builders	13 TRT	System Riggers/Haul Team	4 TRT
Rescue/Extrication Team	2 TRT	Entry	2 TRT
Back Up Rescue Team	2 TRT	Backup	2 TRT
		Attendants	2 TRT
		Communications	1 TRT
		Supplied Air	1 TRT
		Air Monitoring	1 TRT or HM
Subtotal: TRT Operations Personnel	*20*	*Subtotal: TRT Operations Personnel*	*16*
EMS	2 Ops	EMS	2 Ops
Decon/HM	2 HM/Ops	Research/Decon	4 HM/Ops
Rehab/Air Monitoring/Lighting	3 Ops	Rehab/Lighting	2 Ops
Subtotal: Support Personnel	*7*	*Subtotal: Support Personnel*	*8*
TOTAL	**27**	**TOTAL**	**24**

Table 4.4. Critical tasks/personnel needs – Technical Rescue

Structural Collapse	
Critical Task	**Personnel**
IC	1 Ops
Safety	1 TRT
Technical Sector Officer	1 TRT
Shoring System Builders	13 TRT
Search Team	2 TRT
Back Up Search Team	2 TRT
Subtotal: TRT Operations Personnel	*20*
EMS	2 Ops
Lights	1 Ops
Rehab	1 Ops
Certified Structural Engineer	1 Civilian
Subtotal: Support Personnel	*5*
TOTAL	**25**

Table 4.4. - continued. Critical tasks/personnel needs – Technical Rescue

Resource	Rope/High Angle	Swift Water	Trench Rescue	Confined Space	Structural Collapse
Battalion Chief	1	1	1	1	1
EMS Captain	1	1	1	1	1
TRT/RRT Suppression Companies (12 personnel)	3	3	3	3	3
Heavy Rescue Vehicle	1	1	1	1	1
RRT Squad Vehicles	2	2	2	2	2
TRT or RRT Paramedic Trucks (2 medics each)	1 min., 3 max.	1 min., 3 max	1 min., 3 max	1 min., 3 max	1 min., 3 max
Structural Collapse Support Truck	NA	NA	1	NA	1
Air/Power/Light Vehicle	*	*	*	*	*
HazMat Response	*	*	*	*	*
Additional EMS Personnel	*	*	*	*	*
2nd Battalion Chief	*	*	*	*	*
Division Chiefs	*	*	*	*	*
TOTAL TRT PERSONNEL	**16 to 20**	**16 to 20**	**16 to 20**	**16 to 20**	**16 to 20**

Table 4.5. Apparatus requirements for a Technical Rescue Response (Technical Rescue Personnel Only)

*Indicates that these additional non-technical rescue resources would be dispatched depending on the need and complexity of the incident.

Hazardous Materials Incident	
Task	**Personnel**
IC	1 Ops
HazMat Division	1 HMT
HazMat Status	1 Ops
HazMat Safety	1 HMT
HazMat Liaison	1 Ops
HazMat Control Officer	1 HMT
Site Access	1 HMT
Entry Team	2-3 HMT
Back-up Team	2-3 HMT
HazMat Support	1 HMT
Decontamination Team	4-8 *Total* HMT-1 Ops-3 to 7
Research	1 HMT
Equipment	1 HMT
Equipment Assist Crew	4 Ops
Scene Support	0 -8 Ops
HazMat Medical	1 Ops
Tox Medic Teams	2-4 Tox Medics
TOTAL	**25-41**

Table 4.6. Critical tasks/personnel needs – Hazardous Materials

Resource	HazMat Full Alarm	Gas Cylinder Leak	Natural Gas Leak	Chemical Spill
Battalion Chief	1	*	*	1
EMS Captain	1	*	*	1
Engine Company	1	1	1	1
Ladder/ Ladder Tender	1	1	1	1
HazMat/ RRT Companies	3	*	*	3
HazMat Equipment Truck (HZ01, HZ17)	1	*	*	1
Tox Medic Unit	1	*	*	1
RRT Paramedic Trucks (2 medics each)	1	*	*	
Paramedic Units	*	*	*	1
Air/Power/Light Vehicle	*	*	*	
Additional Support Companies	*	*	*	*
TRT Response	*	*	*	*
2nd Battalion Chief	*	*	*	*
Division Chiefs	*	*	*	*
Total HM Technicians *Total Ops Personnel*	*17 to 19* *10*	*8* *May be upgraded to HazMat Full Alarm*	*8* *Upgraded to HazMat Full Alarm if line is 2" or greater*	*15 to 18* *12*
TOTAL PERSONNEL	**27 to 29**	**8**	**8**	**27 to 30**

Table 4.7. Apparatus requirements for current Hazardous Materials Dispatch Protocols

Resource	Bio Detection Alarm	CBRNE	Flammable Liquid Spill	Tanker Fire
Battalion Chief	1	*	*	1
EMS Captain	1	*	*	1
Engine Company	*	1	1	1
Ladder/ Ladder Tender	*	1	1	1
HazMat/ RRT Companies	1	*	*	3
HazMat Equipment Truck (HZ01, HZ17)	1	*	*	1
Tox Medics	1	*	*	1
Paramedic Units	1	*	*	1
RRT Paramedic Trucks (2 medics each)	*	*	*	*
Additional Support Companies	*	*	*	*
Air/Power/Light Vehicle	*	*	*	*
TRT Response	*	*	*	*
2nd Battalion Chief	*	*	*	*
Division Chiefs	*	*	*	*
Total HM Technicians *Total Ops Personnel*	*5* *4*	*8* *May be upgraded to HazMat Full Alarm*	*8* *May be upgraded to HazMat Full Alarm*	*15 – 18* *12*
TOTAL PERSONNEL	**9**	**8**	**8**	**27 to 30**

Table 4.7. - continued. Apparatus Requirements for current Hazardous Materials Response

*Indicates that these additional resources would be dispatched depending on the need and complexity of the incident.

Establishment of an Effective Response Force

Once critical tasks are identified and defined, an effective response force can be established. An effective response force is defined as the minimum amount of equipment and staffing that must reach a specific location within an appropriate time frame. Considering that a fire department cannot hold fire risk to zero, determining an effective response requires a balance between distribution, concentration and reliability that will keep risk at a reasonable level.

The 2006 International Fire Code determines the fire flow requirements for structures of varying hazard types. For high to maximum hazard types, the fire flow requirements are between 4,000 GPM and 6,000 GPM. Although TFD considers factors other than fire flow in determining the risk level of a structure, it does incorporate fire flow requirements into the risk assessment, along with staffing and equipment standards and critical tasking requirements. Table 4.8 represents the initial working fire response to high and moderate risk structures.

Structure risk type/ fire flow requirements	Number of companies required for an initial effective response force	Initial response of firefighters
High Risk 4,000-6,000 GPM • Three or more stories • Two stories with a basement • Hospitals • Institutions with limited mobility occupants • Unsprinklered buildings with over 12,000 square feet of open space • Buildings of great historical significance	12 companies 32 firefighters	2 Battalion Chiefs 2 EMS Captains 4 Engine Companies (4 members in each company) 2 Ladders (4 members in each company) 2 Paramedic Unit (2 members in each company)
Moderate and Remote Risk <3,999 GPM	8 companies 20 firefighters	1 Battalion Chief 2 EMS Captains 3 Engine Companies (4 members in each company) 1 Ladder or Ladder Tender (4 members in each company) 1 Paramedic Unit (2 members in each company)
Special Hazards	Type of incident will dictate the response	

Table 4.8. Structure risk type and initial TFD response.

Identified critical tasks can be combined into company tasks based on staffing levels. Minimum staffing for all engine and ladders companies is four firefighters and two firefighters for each paramedic unit. Table 4.9 represents critical tasking for each company working at a fire in a moderate/typical risk structure. First due responses for other risk categories will utilize this chart as a foundation to build from. It may take more firefighters to complete these tasks but the tasks still must be completed.

Company	Tasks
1st due Engine Company	1. Stretch 200' of 1 ¾" hose line to the point of access for search and rescue and initial fire attack. 2. Operate the pump to supply water and hook-up a 5" supply line. 3. Establish command of initial operations.
2nd Due Engine Company	1. If necessary, lay in a hydrant supply line to the first company. 2. Stretch a second 1 ¾" hose line as a back-up line and/or assist fire attack.
1st due Ladder Company	1. Perform positive pressure and/or vertical ventilation. 2. Secure utilities. 3. Assist with forcible entry. 4. Raise ladders, as needed.
1st due Paramedic Company	1. Assist with search and rescue. 2. Establish EMS group, if needed.
3rd due Engine Company*	1. Establish RIC. 2. Perform support activities, as appropriate.
1st due Battalion Chief	1. Assume command from 1st due company.
1st due EC Captain	1. Assume Status 2. Conduct property survey
2nd due EC Captain*	1. Assume Incident Safety Officer

Table 4.9. Company responsibilities at a moderate risk, working fire incident.
***3rd due Engine Company and 2nd due EC Captain initially respond without lights and siren unless upgraded due to subsequent caller information.**

Based on this same type of incident type and critical task analysis, an effective response force to each type of incident can be determined. Appendix B identifies the different TFD unit responses to different incident types in the City of Tucson.

SECTION FIVE
Distribution and Concentration

Currently, the Tucson Fire Department operates out of twenty-one stations staffed with twenty-two engine companies, nine ladder companies and eighteen paramedic companies, and employs a daily constant staffing of 178 firefighters throughout the City. TFD has historically made station location decisions based solely on geographic location (response diamonds) and call volume. An ancillary, although vital consideration, is the availability of property on which to build. The purchase of Deccan software in 2007 has provided the department with the ability to include response times for all units to a specific location into the equation. This will allow the department to better address distribution of units.

Distribution

Distribution reflects the station and resource locations required to assure a rapid and effective response to an emergency incident. Distribution is measured by the percent of the City covered by the first due unit within an adopted response time goal. As the great majority of TFD's responses are medically related, unit distribution has primarily been based on ALS and BLS responses. These benchmarks included the arrival of a TFD unit at all emergency scenes within five minutes of dispatch 90% of the time and the arrival of an ALS unit within eight minutes 90% of the time. This policy has resulted in less emphasis being placed on first-due fire response.

Figure 5.1 illustrates TFD's current distribution of stations by demand zones and Figures 5.2 illustrates the areas that have received a four-minute response for ALS (all emergency response mode) from a fire station. Not surprisingly, the areas immediately surrounding the individual fire stations receive that level of service. In addition, these figures graphically illustrate the department's emphasis on providing timely ALS response to the community.

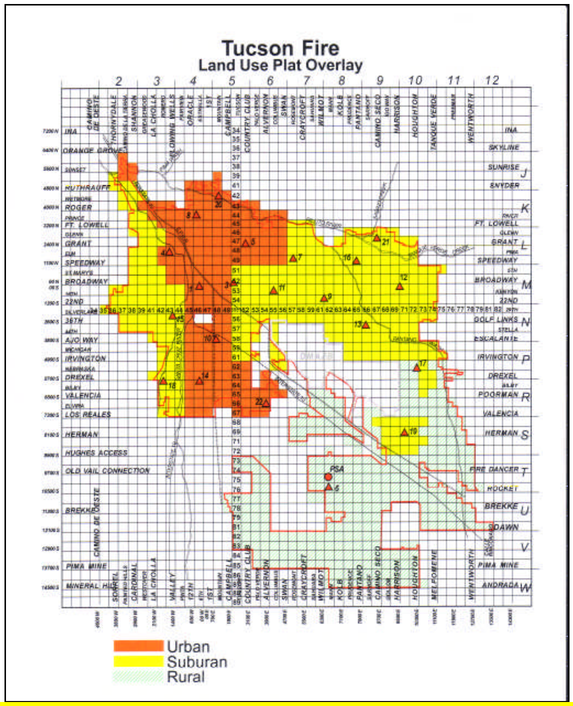

Figure 5.1. Tucson Fire Department station locations in 2008.

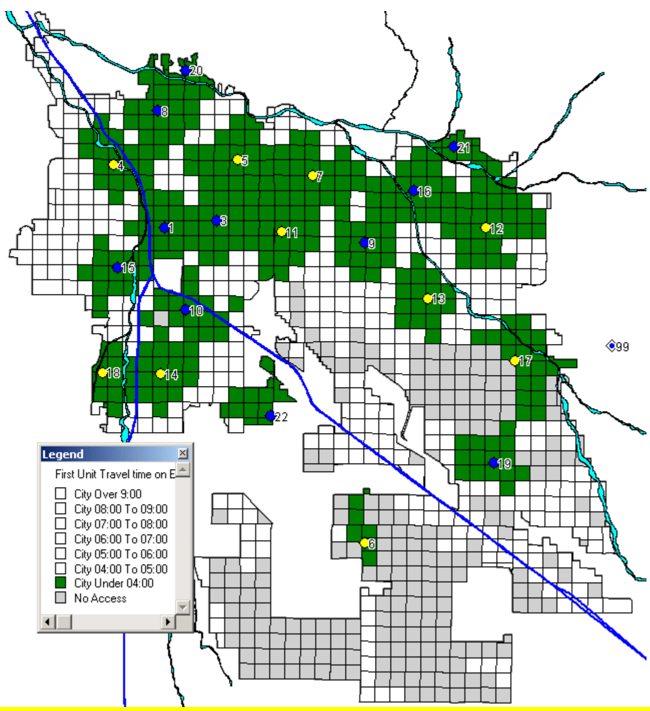

Figure 5.2. Four-minute response times for ALS responses in relation to station location for FY2008. (Emergency Response Mode)

In a continued effort to maximize station and unit location, the Tucson Fire Department Strategic Plan FY2008 to FY2011 and the City's Financial Sustainability Plan further addresses the proposed construction of several stations over the next eight years. Anticipated by those plans is the relocation of current stations or the construction of several new stations to meet current response deficiencies and respond to future growth. Station 3 is to be relocated to south and east of its current location. Infill stations are planned for the areas of Grant/Stone, Kolb/Valencia, and two more are planned as the City expands to the south and southeast.

Concentration

Concentration is the spacing of multiple resources in order to assemble an initial "effective response force" on-scene that can successfully intervene to stop the escalation of an emergency incident. An initial effective response force is not necessarily the total number of units or personnel needed if the emergency has escalated to its maximum potential. Additional units may be requested to supplement the attack and minimize further problems.

Currently, the most glaring area of deficiency is in the far northwest portion of the City covered by Stations 4 and 8 where first due response times are as high as eight minutes. Fortunately, the call history into this area is minimal, but it is an area that is expected to grow with both residential and commercial occupancies. There are several plans under consideration for addressing this area, including:

- Moving Station 8 to the west and providing an infill station to the south.
- Assigning a ladder company to Station 8.
- Developing an automatic aid agreement with the Northwest Fire District which has a station that can respond within 4 minutes to that area.

Other areas of significance within the urban/industrial demand zone where the response goals are not being met are the areas of Stone and Grant, Prince and Campbell, and Campbell and Drexel.

High risk occupancies receive an effective structure fire response that provides a first-due response within 4 minutes, 66% of the time and the balance within 10:30 minutes, 80% of the time. All but four of these occupancies are located in either the urban/industrial or suburban demand zones.

The station construction and relocations indicated in Section Five should improve both the distribution and concentration of units. As there are currently large swaths of vacant land on the outskirts of the City, several of the periphery stations are underutilized. For the most part these areas possess low risk occupancies, minimal population and low call volumes. The City planners do foresee these areas developing in the future. It is anticipated that with this growth, these stations will absorb a greater proportion of the call volume.

TFD's distribution and concentration of stations and units is in need of improvement. However, TFD's Strategic Plan and the City's Financial Sustainability Plan, if fully implemented, will dramatically improve concentration. In addition, the Statewide Mutual Aid Plan has formalized the procedure for requesting additional resources from other response agencies. Individual mutual aid agreements with Davis Monthan Airforce Base, Tucson International Airport and the Raytheon Corporation have been updated within the last year.

SECTION SIX
Response Reliability

Response reliability is the probability that the required amount of staff and apparatus will be available when a fire or emergency call is received. Unlike other statistics in this document, response reliability does not have an easily established benchmark or goal. Response reliability would be 100% if every company was available and in place every time a call was received. In reality, situations exist when a call is received and the first due company is unavailable. This requires the assignment of a later-due company. If the later due company is too far away, the assignment of the call may not be handled within the prescribed response time. The optimal reliability statistic will be a function of the number of calls and the response time for a second-due unit(s) to these incidents. If a first-due area has good second-due coverage (i.e., overlapping four minute drive times), then the statistic becomes less important because the calls are still being handled in an acceptable time frame, even if it s not by the first-due company.

The number of emergency calls per day and training demands, combined with other activities, such as taking apparatus to the Fire Maintenance facility, increases the probability that the prescribed company will be unavailable when a call is received (decreased reliability). To show the response reliability of each station, the Tucson Fire Department utilized Deccan software to isolate calls that were handled by the assigned first-due company.

Response times are the driving force for resource management, and as a result, response reliability takes a secondary priority. Without the benefit of any nationally recognized reliability factor, given the department's current response reliability, the following response reliability standards are being established.

- 80% for engine companies
- 90% for ladder companies
- 70% for paramedic units

Table 6.1 indicates that during FY2008, the Tucson Fire Department had a combined average response reliability for engines, ladders and paramedics of 78.21%, with a low of 63.84% (Station 22), and a high of 94.75% (Station 17). As indicated in Table 6.2, TFD's response reliability for engine companies during FY2008 fell between a high of 93.73% (E21) and a low of 68.24% (E22), with an average of 81.41% for all engine responses. Only two engines were over 90%, while nine were below 80%. Table 6.3 indicates a response reliability for ladder companies during FY2008 between a high of 99.72% (L21) and a low of 75.92% (L16), with an average of 90.74% for all ladder responses. Other than L16, all other ladder companies had a reliability of over 88.9%.

Table 6.4 indicates a response reliability for paramedic companies that is much below that of engine and ladder companies. Seven paramedic units were below the 70% reliability and only two were over 80%. Although PM22 has a very low call volume, this figure may be skewed by its 28% reliability. PM22 is a new company and there is no good explanation at this point why it responds so often out its area. The total low reliability of paramedic companies is most likely a function of these units often transporting patients out of their first due area. As a result, once back in service, they are often dispatched as the 'closest' paramedic unit regardless of first due designation.

Station	# Incidents	1st Due Dispatched	1st Due Not Dispatched	% Reliability
1	7,300	6,111	1,189	83.71
3	3,996	3,108	888	77.77
4	4,588	3,552	1,036	77.41
5	8,294	6,403	1,891	77.20
6	547	435	112	79.52
7	9,760	7,645	2,115	78.32
8	7,162	5,745	1,417	80.21
9	9,094	6,905	2,189	75.93
10	7,324	5,665	1,659	77.35
11	4,284	3,339	945	77.94
12	4,387	3,263	1,124	74.38
13	4,757	3,790	967	79.67
14	6,649	5,010	1,639	75.35
15	3,620	3,027	593	83.62
16	5,656	4056	1,600	71.71
17	763	723	40	94.75
18	1,627	1,317	310	80.95
19	1,290	1,130	160	87.60
20	2,600	2,122	478	81.61
21	1,142	1,052	90	92.12
22	1,532	978	554	63.84
Totals	**96,372**	**75,376**	**20,996**	**78.21**

Table 6.1. Tucson Fire Department Analysis of response reliability by first due first due Engine, Ladder, and Paramedic responses for FY2008.

Engine	# Incidents	1st Due Dispatched	1st Due Not Dispatched	% Reliability
1&2*	3,205	2,842	363	88.67
3	2,667	2,163	504	81.10
4	2,848	2,253	595	79.11
5	2,771	2,211	560	79.79
6	547	435	112	79.52
7	3,283	2,726	557	83.03
8	4,482	3,683	799	82.17
9	3,237	2,419	818	74.73
10	2,742	2,129	613	77.64
11	2,616	2,141	475	81.84
12	2,494	2,132	362	85.49
13	2,894	2,427	467	83.86
14	4,011	3,176	835	79.18
15	2,232	1,924	308	86.20
16	2,033	1,605	428	78.95
17	329	299	30	90.88
18	1,627	1,317	310	80.95
19	784	698	86	89.03
20	873	651	222	74.57
21	399	374	25	93.73
22**	699	477	222	68.24
Totals	**46,773**	**38,082**	**8,691**	**81.41**

Table 6.2. Tucson Fire Department Analysis of response reliability by first due Engine responses for FY2008.
*Two engines are assigned to Station 1.
**Station 22 opened in September of 2007.

Ladder	# Incidents	1st Due Dispatched	1st Due Not Dispatched	% Reliability
1	1,741	1,618	123	92.94
5	2,420	2,152	268	88.93
7	2,831	2,594	237	91.63
9	2,689	2,510	179	93.34
10	2,224	2,030	194	91.28
16	1,271	965	306	75.92
17	434	424	10	97.70
20	955	892	63	93.40
21	361	360	1	99.72
22	427	387	40	90.63
Totals	**15,353**	**13,932**	**1,422**	**90.74**

Table 6.3. Tucson Fire Department Analysis of response reliability by first due Ladder responses for FY2008.

Paramedic Unit	# Incidents	1st Due Dispatched	1st Due Not Dispatched	% Reliability
1	2,354	1,651	703	70.14
3	1,329	945	384	71.11
4	1,740	1,299	441	74.66
5	3,103	2,040	1,063	65.74
7	3,646	2,325	1,321	63.77
8	2,680	2,062	618	76.94
9	3,168	1,976	1,192	62.37
10	2,358	1,506	852	63.87
11	1,668	1,198	470	71.82
12	1,493	1,131	362	75.75
13	1,863	1,363	500	73.16
14	2,638	1,834	804	69.52
15	1,388	1,103	285	79.47
16	2,352	1,486	866	63.18
19	506	432	74	85.38
20	772	579	193	75.00
21	382	318	64	83.25
22*	406	114	292	28.08
Totals	**33,846**	**23,362**	**10,484**	**69.02**

Table 6.4. Tucson Fire Department Analysis of response reliability by first due Paramedic responses for ALS calls for FY2008.
*PM22 went in service in January, 2008.

Time of Day
Data analysis clearly illustrates that time of day impacts response reliability. As indicated previously in Section Two, call volume is highest between the hours of 0900 and 2200, peaking between the hours of 1500 and 1800.

Company Workload
Figure 6.1 and Table 6.5 illustrate the annual distribution for FY2008 of unit responses per station, showing the stations with the most calls, as well as those with multiple pieces of apparatus to respond. This information, coupled with response reliability data, lets TFD further analyze resource distribution and workload issues.

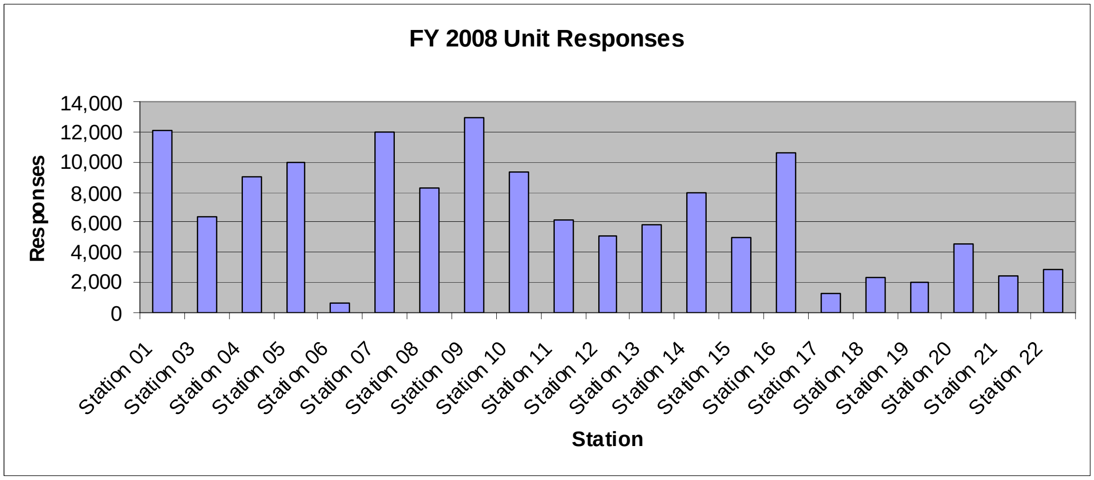

Figure 6.1. Annual distribution for FY2008 of unit responses per station.

As seen in Table 6.5, fire stations experience nearly 3,000 or more calls per year. At 3,000 runs per year, the average number of runs is approximately 8.2 calls per day. Of the fifteen stations near or over this run volume, all have Paramedic Units and the top six have Ladder Companies. Four stations are now running Alpha Trucks. In addition, Station One runs two Engine Companies.

There is obviously a huge disparity in work load among stations and individual units. For all fire stations, the average number of runs per year is approximately 6,511, with a range of 679 calls (Station 6) to 12,904 (Station 9) and a median of 6,181 (Station 11). The two single company stations average 1529 calls. Multi-company stations (engine, ladder, paramedic) average is 8,545 calls, with a range of 2,402 (Station 21) to 12,904 (Station 9) and a median of 9,985 (Station 5). Stations housing one engine and one paramedic company average 6,178 calls, with a range of 1,984 (Station 19) to 9,004 (Station 4) and a median of 6,181 (Station 11).

Engine Companies run an average of 2,758 calls per year, with a range of 635 (E06) to 4,815 (E08) and a median of 2,850 (E12). Ladder Companies run an average of 2,144 calls per year, with a range of 571 (L17) to 3,549 (L09) and a median of 2,368 (L16). Paramedic Units run an average of 2,205 calls per year, with a range of 427 (PM22) to 3,745 (PM09) and a median of 2,800 (PM11).

A study out of the Portland, Oregon area (TriData Report, 1993) indicates that stations that are likely to have more than 2,500 responses annually should preferably have at least two units to share the response workload. Activities beyond 3,000 calls per year usually show significant impact on response times, company availability, and fire fighter fatigue. TFD currently has twenty units that exceed the 3,000 call threshold (10 engine, 7 paramedic and 3 ladder companies), nine of which exceed 3,500 calls per year. Two units, E08 and E14, respond to 4,500 calls apiece.

Station	Responses
9 (1BC, 1EC, 1E, 1L, 1PM, 1AT)	12,904
1 (1BC, 1EC, 2E, 1L, 1PM, 1HM)	12,139
7 (1BC, 1EC, 1E, 1L, 1PM)	11,961
16 (1E, 1L, 1PM, 1AT)	10,600
5 (1E, 1L, 1PM)	9,985
10 (1E, 1L, 1PM, 1AT)	9,380
4 (1E, 1PM, 1TN, 1AT, 1CV*)	9,004
8 (1E, 1PM)	8,222
14 (1E, 1PM)	7,928
3 (1E, 1PM)	6,357
11 (1E, 1PM)	6,181
13 (1E, 1PM)	5,881
12 (1E, 1PM)	5,083
15 (1E, 1PM)	4,966
20 (1E, 1L, 1PM, 1SQ*)	4,601
22 (1BC, 1EC, 1E, 1L, 1PM, TRT)	2,935
21 (1E, 1L, 1PM)	2,402
18 (1E)	2,380
19 (1E, 1PM, 1SQ*)	1,984
17 (1E, 1L, 1ALP*, 1Rehab*)	1,273
6 (1E)	679

Table 6.5. Unit responses per station for FY2008. Total number of units in parentheses.
*Squads, Air/Light Plant, Command Van and Rehab are not staffed and run with available personnel.

Discussion

The issues surrounding response times and resource distribution, concentration and reliability are many and complex. The Tucson Fire Department has attempted to address these issues over the years, taking into account the increased frequency of calls, the changing nature of those calls and the fiscal realities involved with purchasing equipment and property. As a result, nineteen of the twenty-one stations are multi-company with eighteen stations assigned a paramedic unit. Based on Deccan projections, a system-wide improvement should be seen as a result of station construction and relocations, however, this cannot be validated for several years.

When looking at response reliability it is also important to consider the size of the area that a station covers (the bigger the area the more likely a second due call will occur and the longer the travel distances). Due to the amount of area within the boundaries of Tucson, TFD has implemented an in-fill station plan to better address response reliability throughout the City. As the City grows and the department is able to establish more stations that cover less area, the likelihood of a second-due call occurring should decrease. Additionally, if a second-due call does occur the stations will be closer together, allowing for a more rapid response.

Paramedic units present the most significant challenge to maintaining adequate response reliability. Advanced Life Support (ALS) related incidents account for over 33% of all emergency responses, resulting in a disproportionate number of calls being answered by the Paramedic Units. As the number of emergency calls per unit increases, the probability increases that a needed piece of apparatus will already be busy when a call is received. Further, as these units transport ALS patients to the hospital, these transports often take them well out of their first response area. This not only negatively affects their response reliability in their first-due area, conversely, because they are so often out of their area, it also places them in a position of being closer to an incident than the scheduled first-due unit.

Three infill stations (20, 21 and 22) were constructed from the years 2004 and 2007. Station 20 was built in anticipation of future annexation to the north and to absorb some of the call volume of Station 8 as well. This has not proved to be as effective a solution as had been hoped. Station 8, with two units assigned, has seen it's total call volume decrease by only 1.8 calls per day, from 24.3 in FY2006 to 22.5 in FY2008, while Station 20, with three companies assigned, responds to only12.6 calls per day. A similar, and even more dramatic, call volume disparity has occurred with Stations 22 (three companies and 7.7 unit responses per day) and 14 (two companies and 21.7 unit responses per day). To minimize some of this disparity, neighboring plates that would normally be assigned to Stations 8 and 14 were reassigned to Stations 20 and 22, respectively. This has created a longer first-due response time into these areas, in some cases up to an average of 30 seconds, but it has improved response reliability into those areas as well as improved the equity of the work loads.

Formal continuing education sessions at the Training Academy also have a negative effect on response reliability. Historically, each company was required to attend six day-long requirements sessions that took them out of their first-due response areas. In the last year, the training schedule was revised to allow no more than two paramedic units to be out of service at training at one time. This has improved ALS response times city-wide by 9.4% (5:47 in FY2006 to 5:26 seconds in FY2008), but is difficult to show its effect on reliability. In addition, the required training sessions were reduced to five per year.

Out-of-service times after patient transfers has also been found to be a contributing factor affecting response times and reliability. The department has budgeted for an electronic format for writing and distributing reports to help address this issue

The implementation of the Alpha Truck program as an alternative to traditional response schemes has proven successful in improving both first-due responses of emergency response companies as well as overall reliability. These units responded to 6,757 Alpha level (non-emergent medical and/or service calls) in FY2008, freeing up other units that would normally respond to these incidents. More importantly, the Alpha Truck responders are trained to recognize the need for and make recommendations for social service intervention, when appropriate. By providing this service, patients who inappropriately call for emergency response, often because they know of no other resource to turn to, are not directed to a more appropriate level of care. As a result, these units have reduced the number of calls from the fifty most frequent callers by approximately 45%.

"Posting" of units has historically been used on an inconsistent basis. Posting is temporarily stationing a unit in a traditionally busy area when the normal first-due unit is out of its response area. As reliability and work load disparity issues take on greater significance, posting and other resource assignment protocols & policies are being considered.

First-due response times are the driving force for any future station location, with projected call volume and response reliability assuming a lesser priority. Unless an unforeseen call volume increase occurs in a specific area of the City, TFD is confident that response reliability will be maintained in the 70% range for paramedic units, 80% for engines and 90% for ladders. Another consideration of response reliability are those responses that require more than one unit. In reviewing the data from Section Five (concentration) and this section, TFD currently maintains a high response reliability for these calls. As the City grows, however, additional stations and units will be required to maintain the current response times. Alternatives to improve response reliability rarely come without costs and TFD will address the alternatives to determine which, if any, are feasible.

SECTION SEVEN
Recommendations

The Future

The City of Tucson is looking forward to the challenge of maintaining services to a rapidly growing community. Tucson's future includes an increase in population and commercial and industrial development. In addition, single family and multi-family housing will continue to boom.

Tucson's population has steadily climbed from 453,823in 1997 to the current 544,445. Tucson's Department of Urban Planning and Design prepared the Tucson General Plan in 2001 projecting a build-out population of approximately 588,558 citizens by 2010 and 771,438 by 2025.

An increase in population brings transportation concerns as well. Several major road construction and road improvement projects have been identified through the year 2012 that are designed to improve traffic flow through the City. By far the largest of these is the three-year Interstate 10 – Prince Rd. to 29th Street construction project. Others include the widening of Valencia between Alvernon and Kolb Road; rebuilding the 4th Avenue underpass; installation of a downtown trolley system; widening of Silverbell from Grant to Ina Road; Prince Road improvements; and widening of Houghton Road from Speedway to Interstate 10.

The Rio Nuevo downtown revitalization project envisions a number of major construction projects including a new convention center and several high-rise hotels. Commercial development is experiencing rapid growth, particularly in the southwest and southeast areas of the City. High intensity industrial planned land use will continue to respond to existing development patterns within or adjacent to the I-10 corridor, including Tucson International Airport and Davis-Monthan Air Force Base, the Tucson Electric Power generating plant, a major landfill, and Federal and State Prisons.

Plans

Through the evaluation of growth expectations and other elements of this Standards of Response Coverage document the Fire department has established goals and objectives to keep up with growth and improve the level of service to a level that will achieve the goals and objectives listed throughout this document. TFD will continue to project needs and plan for future services through the City of Tucson biannual budget process and the five-year Capital Improvement Plan. Additionally, the department has established the Tucson Fire Department Strategic Plan FY2008-FY2011. This plan will be reviewed, revised and published annually in order to provide a summary of department activities and plans.

Unfortunately, a nation and statewide economic downtown will likely limit the city's ability to adequately fund the Financial Sustainability Plan and, as a result, limits the city's ability to fund many of the planned projects notated in the following recommendations.

After conducting the 2008 Standards of Response Coverage evaluation several new goals and objectives were established and deficiencies in concentration and distribution were identified. The following are some recommendations for addressing current and future issues related to incident response:

1. To make a significant impact on response times, the Financial Sustainability Plan calls for seven new fire stations with 326 fire fighters, paramedics and support (including technology) at a cost of $189 million over the ten-year period. Emergency management and hazardous materials capabilities are proposed with funding of $9 million and 12 staff added over ten years. In addition, 2 stations, including Fire Central, will be relocated to improve service, and existing stations will be upgraded. This plan funds the alternative service delivery model that frees up paramedics and engine companies to respond to high priority calls. In support of this effort, 14 firefighters were added in 2008 to augment the department's constant staffing requirements and avoid overtime costs that result when a station is short of staff.

    a. Construction has begun on Fire Central which will house Fire Station 1, Fire Administration and Fire Prevention. Completion of the project is expected by late 2009.
    b. Relocation of Station 3. This station has reached the end of its useful life and will be directly impacted by the potential widening of Broadway. The tentative location for new Station 3 is 153 S. Plumer Avenue. Land acquisition is currently underway and construction is slated for 2010.
    c. Relocation of Station 10. This station, too, is reaching the end of its useful life is impacted by the encroachment of businesses to the west. Available land is being sought. Construction is slated for 2011.
    d. Infill stations are planned for the areas of Grant/Stone, Kolb/Valencia, and two more are planned as the City expands to the south and southeast.

2. Expand the Alternative Response Vehicle (Alpha Trucks) program from two trucks to five by 2010 to improve response times and reliability. As the Alpha trucks respond to lower priorities calls that other response vehicles have historically responded to, they will increase the capacity for those same units to respond to higher priority calls.

3. Initiate a feasibility study for the 'posting' of less busy units in areas that engender higher call volumes during daylight hours. The research for this document identified a wide disparity in call volume among stations. In addition,

the research also indicated that the greatest stresses on the response system occurred during the daylight hours of 0900 to 2200 hours.

4. Continue to explore the feasibility of mutual/automatic aid agreements with surrounding fire districts to assist with response coverage on the city's borders. Adding units and stations to provide adequate and timely emergency response is extremely expensive. Developing response agreements would reduce response times into these areas while minimizing the duplication of already existing resources.

5. Improve the prevention and building planning record keeping. In attempting to gather data for this document, it was extremely difficult to impossible to get an accurate description of the number and type of commercial occupancies within the City of Tucson. Two major factors contributed this problem. One was the lack of integration of databases between City Development Services and Fire Department Fire Prevention. The second appeared to be a lack of oversight in granting Certificates of Occupancy for new construction and remodeling. It was estimated that as few as 15% of all businesses have a current Certificate of Occupancy

6. Implement a residential sprinkler ordinance for all new construction. As the City continues to expand into remote areas, primarily with high and medium density residential construction, it is not feasible that the department can continue to provide effective and timely service to these remote areas without out a huge outlay of money and resources. Residential sprinkler systems have a proven track record for providing life safety and property protection until the arrival of fire department units. In addition, residential and commercial building inspections will be increased at a cost of $12 million over ten years with 16 additional staff. This plan will increase the frequency of inspections.

7. Review and revise TFD's Strategic Plan and Standards of Coverage documents on an at least an annual basis. This will ensure that both documents are current and that all members of the department are working 'on the same page'. Provide an increased emphasis on emergency service delivery when reviewing the Strategic Plan.

8. Continue working with City of Tucson General Services to streamline its call processing times and to update its reporting system. Although the EMD dispatching protocol helps to ensure the most effective and efficient use of response resources, it results in a dispatching procedure that exceeds NFPA standards by as much as 27 seconds. The current reporting system reports times in averages. A more effective way of reporting is to report in percentiles. General Services has asked for this capability in its next generation of reporting software.

9. The Training and Safety Division will continue to review and revise methods for more efficiently and effectively deliver continuing education. By reducing out of service time at the Training Academy, response capacity throughout the system will be increased.

10. Continue public education programs designed to increase driver awareness to emergency vehicle traffic. Several programs have been implemented in the past with some immediate beneficial results. However, these programs, if not continued, lose their impact over time.

APPENDIX A

Tucson Fire Department Apparatus Assignments

Appendix B

Tucson Fire Department Response Types